TOSHIBA

'83

POWER TRANSISTOR

SEMICONDUCTOR
DATA BOOK

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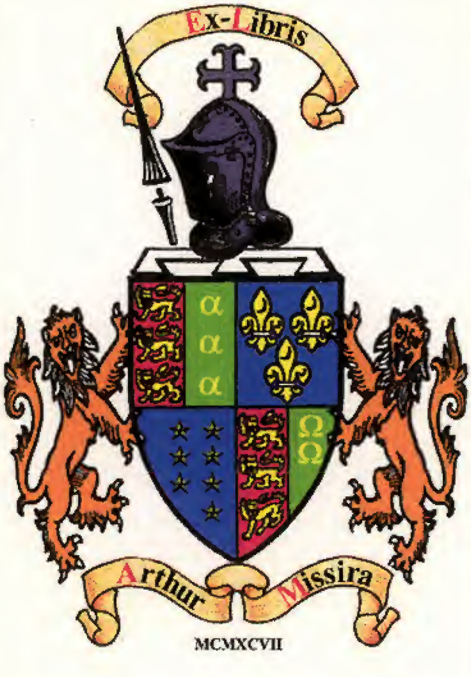
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IMPORTANT NOTICES

The circuit examples illustrated herein are presented only as a guide for the performances or the applications of our products.

Keep in mind that no responsibility is assumed by TOSHIBA for its use, nor for any infringements of patents or other rights of the third parties which may result from its use, and that no license is granted by implication or otherwise under any patent or patent rights of TOSHIBA.

INTRODUCTION

We would like to express our heartfelt thanks for your use of TOSHIBA semiconductor devices.

In recent years, the electronics industry has attained rapid technological advancements. Especially, semiconductor products now play a leading role in the electronic industry, expediting the electronization of all kinds of equipments for both industrial and consumer field. This has been a decisive factor in energy saving and rationalization in an age of low economic growth and has contributed greatly to the innovation of industry and to raising living standards.

In particular, transistors with flexible and extensive applications are expected to make greater strides in the future, being applied in a wider range of use as the pivot of active elements.

TOSHIBA intends to devote itself to enriching and developing products in this field and to producing excellent product groups with both high capacity and high reliability.

This volume comprises detailed technical data for power transistors among our numerous transistor and diode groups. Please use it in combination with the volume on small signal transistors.

We look forward to your continued patronage.

March 1983.

TOSHIBA CORPORATION
SEMICONDUCTOR GROUP
Tsuyoshi Kawanishi
Group Executive

● CONTENTS ●

SELECTION GUIDE 11

EXPLANATION 49

Ratings of Transistors 51

Identification System (Transistors, Accessories and Radiator Holders) 63

Thermal Stability and Radiation Desigen of Transistor Circuit 66

Precautions of Utilizing Transistors 74

Reliability of Semiconductors 78

Characteristics of Transistor 94

Precaution for Handling Hybrid Application Device 111

Power MOS FET 120

Precaution for Handling RF Power Transistor and Module 132

Letter Symbol and Graphical Symbol 135

TECHNICAL DATA 139

ACCESSORIES 1,195

APPLICATION CIRCUIT 1,209

● INDEX ●

Type	Page
2SA473	143
2SA490	145
2SA496/505	147
2SA503/4	149
2SA510/512	152
2SA594	155
2SA656A/7A/8A	157
2SA739	161
2SA814/5	164
2SA816	166
2SA940	167
2SA962A	169
2SA968/8A/8B	171
2SA1012	173
2SA1021	176
2SA1093	179
2SA1094	182
2SA1095	184
2SA1120	186
2SA1144	188
2SA1146	191
2SA1184	194
2SA1195	197
2SA1217	198
2SA1225	200
2SA1241	202
2SA1242	205
2SA1243	207
2SA1244	210
2SA1263	213
2SA1264	215
2SA1265	217
2SA1279	219
2SA1293	222
2SA1301	225
2SA1302	227
2SA1305	229
2SA1306/6A/6B	231
2SA1307	233
2SA1308	236
2SA1322	239
2SA1327	242
2SA1328	244
2SA1329	247
2SB502A/3A	253
2SB552	254
2SB553	257
2SB554	260
2SB595	262
2SB596	264
2SB673/4/5	266
2SB676	269
2SB677	272
2SB678	275
2SB679	276
2SB686	277
2SB688	279
2SB753	281
2SB754	284
2SB755	286
2SB833	288
2SB834	291
2SB863	293
2SB905	295
2SB906	298
2SB907	300
2SB908	303
2SB992	306
2SB993	390
2SB994	312
2SB995	314
2SB996	316
2SB997/8/9	318
2SB1015	321
2SB1016	323
2SB1017	325
2SB1018	327
2SB1019	330
2SB1034	333
2SC108A/9A	337
2SC495/6	338
2SC503/4	340
2SC505/6	343
2SC507	346
2SC510/2	349
2SC519A/20A/21A	352
2SC522/4	355
2SC594	358
2SC790	360
2SC994	361
2SC1001	363
2SC1164	365
2SC1165	367
2SC1169	369
2SC1173	371
2SC1195	373
2SC1199	375
2SC1569	377
2SC1576	379
2SC1617	382
2SC1624/5	384
2SC1626	386
2SC1678	387
2SC1763	389
2SC1764	391

● INDEX ●

Type	Page
2SC1765	393
2SC1955	395
2SC2068	397
2SC2073	399
2SC2075	401
2SC2098	405
2SC2099	407
2SC2101	409
2SC2102	411
2SC2103A	413
2SC2104	415
2SC2105	417
2SC2106	419
2SC2117	421
2SC2118	423
2SC2173	425
2SC2178	427
2SC2181	429
2SC2194A	431
2SC2200	433
2SC2204/20	435
2SC2231/31A	436
2SC2233	439
2SC2238/8A/8B	442
2SC2242	444
2SC2270	447
2SC2290	449
2SC2318	451
2SC2379	453
2SC2380	455
2SC2381	457
2SC2391	459
2SC2395	461
2SC2420	463
2SC2444	465
2SC2456	466
2SC2481	469
2SC2483	472
2SC2508	475
2SC2509	477
2SC2531	479
2SC2552	481
2SC2553	484
2SC2555	487
2SC2562	490
2SC2563	493
2SC2564	496
2SC2565	498
2SC2638	500
2SC2639	502
2SC2640	504
2SC2641	506
2SC2642	508
2SC2643	510
2SC2650	512
2SC2652	515
2SC2704	517
2SC2706	520
2SC2782	523
2SC2783	525
2SC2790	527
2SC2791	531
2SC2792	533
2SC2793	535
2SC2824	537
2SC2877	540
2SC2879	542
2SC2913	544
2SC2914	547
2SC2983	550
2SC3006	552
2SC3007	554
2SC3051	557
2SC3072	560
2SC3073	562
2SC3074	565
2SC3075	568
2SC3076	571
2SC3148	574
2SC3180	577
2SC3181	579
2SC3182	581
2SC3233	583
2SC3235	585
2SC3236	588
2SC3239	591
2SC3257	594
2SC3258	597
2SC3280	600
2SC3281	602
2SC3297	604
2SC3298/8A/8B	606
2SC3299	608
2SC3303	611
2SC3306	612
2SC3307	615
2SC3308	618
2SC3309	621
2SC3310	624
2SC3335	625
2SC3344	628
2SC3345	631
2SC3346	634
2SC3376	637
2SD523	641

● INDEX ●

Type	Page
2SD524	644
2SD525	647
2SD526	649
2SD548	652
2SD549	655
2SD552	658
2SD553	661
2SD633/4/5	664
2SD640	668
2SD641	671
2SD647A/697A	674
2SD648A	677
2SD664	680
2SD683/3A	683
2SD684	686
2SD684A	688
2SD685	690
2SD686	693
2SD687	696
2SD688	699
2SD689	700
2SD698	701
2SD700	704
2SD716	707
2SD717	709
2SD718	712
2SD777	714
2SD797	720
2SD798	723
2SD799	726
2SD811	729
2SD818	732
2SD819	734
2SD820	736
2SD821	737
2SD822	739
2SD841	741
2SD842	744
2SD843	747
2SD844	750
2SD845	752
2SD867	754
2SD868	757
2SD869	760
2SD870	763
2SD871	766
2SD873	769
2SD877	772
2SD878	774
2SD880	777
2SD1034A	779
2SD1052	782
2SD1052A	785
2SD1069	788
2SD1087	792
2SD1088	795
2SD1090	797
2SD1092	800
2SD1148	806
2SD1160	808
2SD1165A	811
2SD1166	814
2SD1187	817
2SD1208	820
2SD1220	825
2SD1221	828
2SD1222	830
2SD1223	833
2SD1224	836
2SD1279	839
2SD1294	842
2SD1313	845
2SD1314	848
2SD1353	851
2SD1354	853
2SD1355	855
2SD1356	857
2SD1357/8/9	859
2SD1360	862
1SD1361	864
2SD1362	866
2SD1363	869
2SD1405	872
2SD1406	874
2SD1407	876
2SD1408	878
2SD1409	880
2SD1410	882
2SD1411	884
2SD1412	887
2SD1425	890
2SD1426	893
2SD1427	896
2SD1428	899
2SD1429	902
2SD1430	903
2SD1431	904
2SD1432	905
2SD1433	906
2SD1438	907
2SD1460	909
2SJ115	913
2SK324	919
2SK325	922
2SK355	925

● INDEX ●

Type	Page
2SK356	926
2SK357	927
2SK358	930
2SK385	933
2SK386	934
2SK387	935
2SK388	936
2SK405	937
2SK417	940
2SK418	941
2SK419	942
2SK420	943
2SK421	944
2N3055	947
2N3713	949
2N3714	951
2N3715	953
2N3716	955
2N3771	957
2N3772	959
2N3773	961
2N3789	963
2N3790	965
2N3791	967
2N3792	969
2N4398	971
2N4399	974
2N5038	977
2N5039	979
2N5301	981
2N5302	984
2N5303	947
2N6249	990
2N6250	993
2N6251	996
2N6546	999
2N6547	1002
BD135/7/9	1007
BD136/8/40	1010
BD233/5/7	1013
BD234/6/8	1016
BF457/8/9	1021
BF469/471	1024
BF470/472	1028
BU126	1035
BU204/5	1037
BU207	1039
BU208	1040
BU208A	1042
BU326A	1045
BU407D	1048
BU500	1051
BUY71	1055
TBF869/871	1059
TBF870/872	1063
TSB3055	1069
S1236	1073
S1237	1076
S1298	1079
S1375	1082
S1376	1084
S1377	1086
S1732	1088
S1954	1090
S1955	1092
S2000	1094
S2000A	1096
S2054	1099
S2055/55A	1101
S2056	1102
S2818/8A	1003
S2824	1004
S-AU3	1009
S-AU4	1112
S-AU5L/5M/5H	1115
S-AU6L/6M/6H	1119
S-AU7	1123
S-AV5	1129
S-AV6	1132
S-AV7	1135
S-AV8	1138
S-AV9L/9H	1141
S-AV10L/10H	1145
MG15G1AL3	1151
MG15G6EL1	1155
MG30G1BL2	1159
MG30G2CL3	1162
MG50G1BL2	1166
MG50G2CL3	1169
MG75H2DL1	1173
MG100G1AL1	1177
MG100G1FL1	1181
MG100H2DL1	1185
MG200H1AL1	1189

POWER
TRANSISTORS
SELECTION GUIDE

Selection Guide

Transistors (Consumer Use)

General-Purpose High Frequency Transistors (Classification Table)

Uses / Frequency (MHz)	Application	Small Signal		Large Signal
		Amplification	Oscillation	
0.55	TV AGC synchronization	2SC1815, 2SA1015, 2SC2458, 2SA1048	2SC1815 2SC2458 2SC380TM 2SC2669	
	BC Band Radio	2SC1815, 2SC2458, 2SC380TM, 2SC2669 2SC941TM, 2SC2670		
1.0	TV Video amplification	2SC1959, 2SC1815, 2SC2458		2SC2229, 2SC2068, 2SC1569, 2SC2482, 2SC2333, 2SC3334, 2SC3335, 2SA1320, 2SA1321, 2SA1322, S1298, S2057/A, S2058/A BF422, BF423, BF457 BF458, BF459, BF469 BF470, BF471, BF472
2.0				
3.0	TV SIF		2SC380TM 2SC2669 2SC2995	
	Short Wave Radio	2SC380TM, 2SC2669, 2SC2995		
10	FM IF	2SC380TM, 2SC2669, 2SC2995		
20	AM, SSB Transceiver	2SC2668, 2SC2669 2SC2995, 2SC1923, 2SC380TM, 3SK59, 3SK73, 3SK101 2SK161 2SK241, 2SK192A	2SC2995 2SC380TM 2SC2669	2SC1678, 2SC2098 2SC1036, 2SC2075

Uses Frequency (MHz)	Application	Small Signal		Large Signal
		Amplification	Oscillation	
30 50	TV PIF (Europe) TV PIF (USA) Transceiver TV PIF (Japan) FM	2SC3125 2SC2215, 2SC2216, 2SC2717 2SC382TM (1st), 2SC383TM (3rd), 2SC388ATM (3rd), 2SC1923, 2SC2668, 2SC2995 2SK161, 2SK192A 3SK59, 3SK73, 3SK101, 2SK241, 3SK114	2SC1923 2SC2668 2SC2995	
100 200	VHF TV	3SK101, 3SK114 2SC2805, 2SC2806, 2SC3122, 2SC2347, 2SC2348, 2SC3123, 2SC3136, 2SC3172 3SK63	2SC2806 2SC2349 2SC3124	2SC994 2SC1199 2SC1164, 2SC2318, (CATV)
300 500	UHF TV	2SC2498, 2SC2499, 2SC2644, 2SC3098, 2SC3099, 2SC2804, 2SC2805, 2SC3137, 2SC3119, 2SC3120, 2SC3121, 3SK115, 3SK102, 3SK121,	2SC3120 2SC3121 2SC3137 2SC2805 2SC2347	2SC1164, 2SC1199, 2SC2318, 2SC2319 (CATV)
1000		2SC2753, 2SC3011, 2SA1245 2SC2876, 2SC3268, 2SC3301, 2SC3302		
5000				

General Purpose Low Frequency Transistors (Classification Table)

Classification	Collector Dissipation Pc	Silicon Transistor					
		VCEO (VCER)					
		~50V	50V~79V	80V~99V	100V~120V	121V~400V	1000V~
Low Power Low Noise	<500mW	2SC2878 (2SK146 2SJ73 2SK147 (2SK170 2SJ74 (2SK147 2SJ72 2SK270 2SJ90 (TBC547~550 TBC557~560	2SK30ATM 2SK246 2SK117 2SK118 2SK184 (2SA1015 2SC1815 2SC732TM (2SC2458 2SA1048 (TBC546 TBC556	(2SC2868 2SA1158	(2SC2240 2SA970		
Low Power Amplification	0.5~1W	(2SC1959 2SA562TM (2SC2710 2SA1150 (TBC327/8 TBC337/8	(2SC1815 2SA1015 (2SC2458 2SA1048		(2SC2240 2SA970 (2SC2459 2SA1049		
Medium Power Output	0.51~1W	(2SC2120 2SA950 2SC2703 (2SC2500 2SA1160 (2SC2236 2SA966 (2SC496 2SA496 (BD135 BD136	(2SC2655 2SA1020 (2SC495 2SA505 2SC2794 (BD137 BD138	(2SC1627 2SA817 (2SC1627A 2SA817A (BD139 BD140	(2SC2235 2SA965	(2SC2229* 2SA949 2SC2230* 2SC2230A* 2SC2482* (2SC2383* 2SA1013* (2SC2705 2SA1145	
	1.1~10W (Tc=25°C)	(2SA2877 2SA1217 (2SC2270 2SA1120 (2SC1173 2SA473		(2SA1626 2SA816 (S1375 S1376		(2SC2704 2SA1144 2SC2068* S1377*	

*: TV use (: Complementary pair ※ Ask separately.

Classification	Collector Dissipation PC	Silicon Transistor					
		VCEO (VCER)					
		~50V	50V~79V	80V~99V	100V~120V	121V~400V	1000V~
	11~30W (Tc=25°C)	BD233 BD234	2SC2562 2SA1012 2SC790 2SA490 2SD880 2SB834 (60V) 2SD1052 2SD1052A BD235 BD236	2SD526 2SB596 BD237 BD238	2SC2824 2SA1184 2SC1625 2SA815	2SC1569* 2SC2231* 2SC2231A* 2SC1624 2SA814 2SC2073* 2SA940 2SC2233* 2SC2456* 2SC2242* 2SC2238 2SA968 2SC2238A 2SA968A 2SC2238B 2SA968B 2SC2481* 2SA1021* 2SC2483* 2SA1195*	
High Power Output	31~60W (Tc=25°C)		2SB553 2SD553 2SD754 2SD844	2SB753 2SD843 S1236 S1237	2SD525 2SB595 2SD716 2SB686 *2SC3180 2SA1263	2SD1069* 2SD1090* 2SC1617* BU407D* BU326A*	2SD818* 2SD819* 2SD820* 2SD821* 2SD822* 2SD811* 2SD868* 2SD869* 2SD870* 2SD871* 2SD1279* BU205* BU208* BU208A* BUY71* S2818* S2818A*
	61~200W (Tc=25°C)		2SD717 2SD1092* 2SD777* 2SD1294* 2SD1208*	2SD1187	*2SC3181 2SA1264 2SD718 2SB688 2SC2563 2SA1093 2SD1148 2SB863 *2SC3182 2SA1265	2SD424 2SB554 2SD845 2SB755 2SC2564 2SA1094 2SC2565 2SA1095 2SC2706 2SA1146 2SC1195* 2SC3182 2SA1265 2SC3280 2SA1301 ※2SC3281 2SA1302	2SD1425* 2SD1426* 2SD1427* 2SD1428* 2SD1429* 2SD1430* 2SD1431* 2SD1432* 2SD1433* 2SD1434*

*: TV use (: Complementary pair ※ Ask separately

Transistors For Audio Equipment

AM/FM Tuner

Uses		TO-92	Mini	Super Mini	TO-72	H-SSTM	μ-X	DO-35
FM	RF	2SC1923	2SC2668 2SK161 2SK192A 2SK241	2SC2714 2SK211 2SK210 2SK302	3SK59	3SK73	3SK101 3SK114	
	MIX	2SC1923	2SC2668	2SC2714	3SK59	3SK73	3SK101 3SK114	
	LO	2SC1923	2SC2668 2SC2995	2SC2714 2SC2996				
	IF	2SC380TM	2SC2669	2SC2715				
	AFC							IS2236*
AM	RF	2SC941TM	2SC2670	2SC2716				
	CONV & IF	2SC1815 2SC380TM 2SC941TM	2SC2458 2SC2669 2SC2670 2SC2995	2SC2712 2SC2715 2SC2716 2SC2996				
AM Tuning			ISV100* ISV102* ISV149*					
FM Tuning			ISV101* ISV103* ISV147*					
FM AGC		ISV99*		ISV128*				

*Diode

Low Frequency Small Signal Amplification

Application	Package					
	TO-92		Mini		Super Mini	
General purpose	2SC1815 2SC2868	2SA1015 2SA1158	2SC2458 2SC2459	2SA1048 2SA1049	2SC2712 2SC2713	2SA1162 2SA1163
General purpose (Low Noise)	2SC1815Ⓛ	2SA1015Ⓛ	2SC2458Ⓛ	2SA1048Ⓛ	2SC3323	2SA1311
	2SC732 TM					
E.Q Amp Diff.	2SC2240	2SA970	2SC2459	2SA1049	2SC3324	2SA1312
Main Amp Diff.	2SC2240	2SA970			2SC3324	2SA1312
Low Frequency Amplifier	2SC2120	2SA950	2SC2710	2SA1150	2SC3265	2SA1298
	2SC1959	2SA562TM			2SC2859	2SA1182
Impeadance Converter	2SK246	2SJ103	2SK330	2SJ105	2SK208	2SJ106
	2SK30ATM		2SK118		2SK208	
Low NoiseAudioAmplifier	2SK117		2SK184		2SK209	
Muting	2SC2878		2SC3327		2SC3326	

Structure / Application	Single Type		Dual Type	
	N-ch	P-ch	N-ch	P-ch
E.Q.Amp Diff	2SK170	2SJ74	2SK240	2SJ75
	2SK147 2SK369	2SJ72 2SJ111	2SK146	2SJ73
			2SK270 2SK389	2SJ90 2SJ109
Main Amp Diff			2SK270 2SK389	2SJ109

Power Amplifier

HF Series

Stage / Po	Diff. Amp	Pre. Driver		Driver		Out Put	
		NPN	PNP	NPN	PNP	NPN	PNP
3W	–	–	–	2SC1959	–	2SC2236	2SA966
5W	–	–	–	2SC1959	–	2SC2877	2SA1217
20W	2SA1015	2SC1627	–	2SC1627	2SA817	2SD880	2SD834
25W	2SA1015	2SC1627	–	2SC1627	2SA817	2SD526	2SB596
35W	2SA1015	2SC2705	2SA1145	2SC1627A	2SA817A	2SD716 2SC3180	2SB686 2SA1263
50W	2SA970	2SC2705	2SA1145	2SC2235	2SA965	2SD718 2SC3181	2SB688 2SA1264
70W	2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SD1148 2SC3182	2SB863 2SA1265
80W	2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SD845 2SC3280	2SB755 2SA1301
100W	2SA970	2SC2705	2SA1145	2SC2238	2SA968	2SC3281	2SA1302
150W	2SA970	2SC2704	2SA1144	2SC2238	2SA968	2SD845 × 2 2SC3281 × 2	2SB755 × 2 2SA1302 × 2

SHF Series

50W	2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SC2563	2SA1093
70W	2SA970	2SC2705	2SA1145	2SC2238	2SA968	2SC2706	2SA1146
80W	2SK270	2SC2705	2SA1145	2SC2238	2SA968	2SC2564	2SA1094
100W	2SK270	2SC2704	2SA1144	2SC2238	2SA968	2SC2565	2SA1095
150W	2SK270	2SC2704	2SA1144	2SC2238A	2SA968A	2SC2564 × 2	2SA1094 × 2
200W	2SK270	2SC2704	2SA1144	2SC2238B	2SA968B	2SC2565 × 3	2SA1095 × 3
70W	2SK270	–	–	2SC2704	2SA1144	2SK405**	2SJ115**
120W	2SK270	–	–	2SC2704	2SA1144	2SK405×2**	2SJ115×2**

** : Power MOS FET.

Transistor For TV

Tuner

Uses		TO-92	μ-X	Equivalent to TO-236	1-5G1A	DO-35	1-2G1A	1-2J1A
UHF	RF		3SK102(MOS) 3SK121(GaAs) 3SK115(MOS) 2SC2304	2SC3119				
	MIX		2SC2805 2SC3137	2SC3121 2SC3120				
	OSC	2SC2347	2SC2805 2SC3137	2SC3121 2SC3120				
	Tuning				1SV123*			1SV153*
	AFC				1SV123*	1S2094*		1SV153*
VHF	RF	2SC2348	3SK101(MOS) 3SK114(MOS)	2SC3122				
	MIX	2SC3136	2SC3172 3SK101(MOS) 3SK114(MOS)	2SC3123				
	OSC	2SC2349	2SC2806	2SC3124				
	Tuning				1SV123* 1SV138* 1SV75*			1SV153*
	AFC				1SV123*	1S2094*		1SV153*
	Band SW					1S2186*	1SS155*	

* : Diode

Video, Chroma-System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Driver	■	■	■				2SA562TM
	■	■	■	■	■	■	2SA1015
				■	■	■	2SC1815
Output	■	■		■			2SC2068/S1298 TBF869/TBF870 TBF871/TBF872
		■	■		■	■	2SC2482
		■	■		■	■	2SC2456 2SA1322/2SC3335
			■			■	2SC2229 2SA1321/2SC3334
	■	■	■				2SC3333/2SA1320 BF422/BF423

Vertical Deflection System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Oscillator				■	■	■	2SC1815
				■	■	■	2SA1015
Driver	■	■	■				2SC2229
				■	■	■	2SC1959
Output	■	■					2SC2073／2SA940 S1236／S1237
		■	■	■	■		2SC2481／2SA1021
				■	■		2SD880 ／2SB834
				■	■		2SC1173／2SA473
					■		2SC496 ／2SA496
					■	■	2SC2236／2SA966

L : Large Size Screen
M : Middle Size Screen
S : Small Size Screen

PIF, SIF, AGC, Synchronous Separation, Synchronous Amplifier

PIF			SIF	AGC	Synchronous Separation	Synchronous Amplification
1st	2nd	3rd				
2SC382TM 2SC2215	2SC382TM 2SC2215	2SC383TM 2SC388ATM 2SC2216 2SC2717 2SC3125	2SC380TM 2SC380ATM	2SC1815 2SA1015	2SC1815 2SA1015	2SC1815 2SA1015

Sound Output

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Output	■	■					2SC2483／2SA1195
	■	■	■				2SC2481/2SA1021
		■	■				2SC2231×2 or2SC2231A×2
		■	■				2SC2230×2 or2SC2230A×2
		■	■				2SC2383/2SA1013
				■	■		2SD880 ／2SB834
				■	■		2SC1173／2SA473
					■	■	2SC2236／2SA966
						■	2SC2120／2SA950

Horizontal Deflection System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Oscillator	■	■	■	■	■	■	2SC1815
	■	■	■	■	■	■	2SA1015
Driver	■	■	■				2SC2068, S1377
	■	■	■				2SC2456
	■	■	■				2SC2482
				■	■	■	2SC2229
				■	■	■	2SC1959
Output	■	■		■			2SD822, 2SD1279, 2SD1433
	■	■		■			2SD821, BU208A, 2SD1432, S2000A
	■	■		■			2SD820, BU208, 2SD1431, S2000
		■	■		■	■	2SD819, 2SD1430
		■	■		■	■	2SD818, BU205, 2SD1429, S2056
	■	■		■			2SD871*, S2818A*, 2SD1428*, S2055A
	■	■		■			2SD870*, S2818*, 2SD1427*, S2055*
		■	■		■	■	2SD869*, 2SD1426*
		■	■		■	■	2SD868*, 2SD1425*
			■	■			2SC1617, BUY71
				■	■		2SD1069*, BU407D
					■	■	2SC2233

*Built in Damper Diode

Power Supply

Uses		Color TV			B/W TV			Type	Remarks
		L	M	S	L	M	S		
Series Regulator	Error Amplifier	■	■	■				2SC2229, S1854	high+B
					■	■	■	2SC1815	Low+B
					■	■	■	2SA1015	Low+B
	Driver	■	■	■				2SC2229	high+B
					■	■	■	2SC1815	Low+B
					■	■	■	2SA1015	Low+B
	Output	■	■	■				2SD1208, 2SD777	high h_{FE}
			■	■				2SD1092	high h_{FE}
		■	■					2SC1195	
			■	■				2SD1090, 2SD1294	high h_{FE}
					■	■	■	2SD880 or 2SB834	
				■		■	■	2SD1052, 2SD1052A	high h_{FE}
Switching Regulator	Driver	■	■		■	■		2SC2655	
		■	■		■	■		2SC2703	
				■			■	2SC2236	
				■			■	2SC2120	
	Output	■	■		■	■		2SD822, 2SD1279 2SD1434	
			■	■	■	■	■	2SD811, 2SD841, BU326A	
		■						2SC2790, 2SC2790A	High Speed

Package	Type	Application	Maximum Rating		
			V_{CEO}(V)	I_C(mA)	P_C(mW)
TO-92	2SC2498	VHF~UHF Low noise amplifier	20	50	300
	2SC2499		20	30	300
	2SC2753		12	70	300
	2SC2644	VHF~UHF Wide-band amplifier	12	120	500
μ-X	2SC2876	VHF~C band Low noise amplifier	7.5	80	200
Epuivalent to TO-236	2SA1245	VHF~UHF Low noise amplifier	− 8	−30	150
	2SC3098		20	50	150
	2SC3099		20	30	150
	2SC3011	UHF~C band Low noise amplifier	7	30	150
Power Mini	2SC3268	VHF~UHF Low noise amplifier	12	70	800
	2SC3301	VHF~C band Low noise amplifier	7.5	80	800

Package	Type	Application	Electrical Characteristic(TYP)			
			f_T(GHz)	$S21_e^2$	NF(dB)	f(GHz)
TO-92	2SC2498	UHF~UHF Low noise amplifier	3.5	14.5	2.5	0.5
	2SC2499		4.0	15.0	1.7	
	2SC2753		5.0	10.5	1.7	1.0
	2SC2644		4.0	14.5	2.3	0.5
μ-X	2SC2876	UHF~C band Low noise amplifier	7.0	10.5	2.3	1.0
Epuivalent to TO-236	2SA1245	VHF~UHF Low noise amplifier	4.0	9.5	3.0	
	2SC3088		3.5	14.5	2.5	0.5
	2SC3099		4.0	15.0	1.7	
	2SC3011	UHF~C band Low noise amplifier	6.5	9.0	2.3	1.0
Power Mini	2SC3268	VHF~UHE Low noise amplifier	5.0	9.5	2.0	1.0
	2SC3301	UHF~C band Low noise amplifier	7.0	9.0	2.3	

Chip Device For Hybrid IC (1)

Super Mini Transistor (Equivalent to TO-236)

Type	Application	Electrical Characteristic				Marking	Complementary	Similar Type TO-92 (mini transistor)	Remarks
		V_{CEO} (V)	I_c(mA)	P_c(mW)	T_J(°C)				
2SA1162	Low frequency amplifier	−50	−150	150	125	S	2CC2712	2SA1015 (2SA1048)	–
2SC2712	Low frequency amplifier	50	150	150	125	L	2SA1162	2SC1815 (SC2458)	–
2SA1163	Low frequency high voltage amplifier	−120	−100	150	125	C	2SC2713	2SA970 (2SA1049)	–
2SC2713	Low frequency high voltage amplifier	120	100	150	125	D	2SA1163	2SC2240 (2SC2459)	–
2SC2714	FM RF amplifier	30	20	150	125	Q	–	2SC1923 (2SC2668)	–
2SC2715	AM convertor, FM IF amplifier	30	50	150	125	R	–	2SC380TM (2SC2669)	–
2SC2716	AM RF amplifier	30	100	150	125	F	–	2SA941TM (2SC2670)	–
2SA1182	Low frequency amplifier	−30	−500	150	125	Z	2SC2859	2A562TM	–
2SC2859	Low frequency amplifier	30	500	150	125	W	2SA1182	2SC1959	–
2SC2532	LED driver	40	300	150	125	A	–	2SC982TM	–
2SC2996	FM RF amplifier	30	50	150	125	G	–	(2SC2995)	–
2SA1255	High voltage amplifier	−200	−50	150	125	O	2SC3138	–	–
2SC3138	High voltage amplifier	200	50	150	125	N	2SA1255	–	–
*2SC3011	UHF ∼ C band low noise noise amplifier	7	30	150	125	MA	–	–	f_T=6.5GHz
*2SC3098	VHF ∼ UHF band low noise amplifier	20	50	150	125	MB	–	2SC2498	f_T=3.5GHz
*2SC3099	VHF ∼ UHF band low noise amplifier	20	30	150	125	MC	–	2SC2499	f_T=4GHz
*2SA1245	High speed switching	−8	−30	150	125	MD	–	–	f_T=4GHz
2SC3119	UHF-TV RF amplifier	20	20	150	125	HA	–	–	f_T=900 MHz
2SC3120	UHF-TV convertor	15	50	150	125	HB	–	–	f_T=2.4GHz
2SC3121	UHF-TV oscillator	15	50	150	125	HC	–	–	f_T=1.5GHz
2SC3122	VHF-TV RF amplifier	30	20	150	125	HD	–	2SC2348	f_T=400MHz
2SC3123	VHF-TV convertor	20	50	150	125	HE	–	2SC3136	f_T=900MHz, MIN
2SC3124	VHF-TV oscillator	15	50	150	125	HF	–	2SC2349	f_T=600MHz, MIN
2SC3125	TV PIF amplifier	25	50	150	125	HH	–	2SC388ATM	f_T=350MHz

*Microwave transistor

FET

Type	Application	Electrical characteristic (Ta = 25°C)					Marking	Similiar Type	Remarks
		V_{DSX}** V_{GDO} V_{GRD}* (V)	I_G,I_D* (mA)	P_D(mW)	I_{DSS}(mA)	$\lvert Y_{fs}\rvert$ (mS)			
2SK208	Low frequency amplifier	−50	10	100	0.3 ~ 6.5	1.2 MIN.	J	2SK30ATM	
2SK209	Low noise low frequency amplifier	−50	10	150	0.6 ~ 14	15	X	2SK117	
2SK210	FM RF amplifier	−18*	10	100	3.0 ~ 24	7 TYP.	Y	2SK192A	
2SK211	FM RF amplifier	−18*	10	100	1.0 ~ 10	9 TYP.	K	2SK161	
2SK302	VHF band amplifier	20**	30*	150	1.5 ~ 14	10 TYP.	T	2SK241	MOS type FET

Diode

Type	Application	Electrical Characteristic (Ta = 25°C)					Marking	Similar Type	
		V_R(V)	I_F(mA)	C_T(PE)	NF(dB)	Rs(Ω)			
ISS154	UHF ~ S band mixer detecter	6	30	0.8	9 MAX.	–	BA	–	
ISV128	VHF ~ UHF band attenuator	50	50	0.25	–	7	BB	ISV99	
ISS181	High Speed Switching	80	100	4.0	–	–	A3	–	Cathode Common
ISS184	High Speed Switching	80	100	4.0	–	–	B3	–	Anode Common
ISS226	High Speed Switching	80	100	4.0	–	–	C3	–	Series Type

Chip Device For Hybrid IC (2)

Power Mini Transistor (Equivalent to SOT-89)

Type	Application	Electrical Characteristic (Ta = 25°C)					Marking	Complement-ary pair	Similar Type T092MOD (TO-92)	Remarks
		V_{CEO} (V)	I_C (A)	P_C (W)	P_C* (W)	T_J (°C)				
2SA1200	High voltage switching, audio pre-driver	−150	−0.05	0.5	0.8	150	B	2SC2880	2SA949	
2SC2880	High voltage switching, audio pre-driver	150	0.05	0.5	0.8	150	A	2SA1200	2SC2229	
2SA1201	Power amplifier, audio driver	−120	−0.8	0.5	1.0	150	D	2SC2881	2SA965	
2SC2881	Power amplifier, audio driver	120	0.8	0.5	1.0	150	C	2SA1201	2SC2235	
2SA1202	Power amplifier, audio driver	−80	−0.4	0.5	1.0	150	F	2SC2882	2SA817A	
2SC2882	Power amplifier, audio driver	80	0.4	0.5	1.0	150	E	2SA1202	2SC1627A	
2SA12-3	Power amplifier	−30	−1.5	0.5	1.0	150	H	2SC2883	2SA966	
2SC2883	Power amplifier	30	1.5	0.5	1.0	150	G	2SA1203	2SC2236	
2SA1204	Power amplifier	−30	−0.8	0.5	1.0	150	R	2SC2884	(2SA950)	
2SC2884	Power amplifier	30	0.8	0.5	1.0	150	P	2SA1204	(2SC2120)	
2SA1213	Power amplifier, switching	−50	−2.0	0.5	1.0	150	N	2SC2873	2SA1020	Low V_{CE}(sat)
2SC2873	Power amplifier, switching	50	2.0	0.5	1.0	150	M	2SA1213	2SC2655	Low V_{CE}(sat)
2SC2982	Strobo flash	10	2.0	0.5	1.0	150	S	–	2SC2500	
2SC3268	RF Low noise amplitcer	10	0.07	0.3	0.8	125	ME	–	(2SC2753)	VHF ~ UHF
2SC3301	RF Low noise amplitcer	7.5	0.08	0.3	0.8	125	MA	–	–	VHF ~C Band

PC *Mounted on 250mm² x 0.8mm Ceramic board

Chip Device For Hybrid IC (3)

Power Mold Transistor

Type	Application	Electrical Characteristic (Ta = 25°C)					Complimentary Pair	Similar Type TO-126,220	Remarks
		V_{CEO} (V)	I_C (A)	P_C (W)	P_C* (W)	T_J (°C)			
2SA1225	Driver Power amplifier	−160	−1.5	1.0	10	150	2SC2983	2SA9688	
2SC2983	Driver Power amplifier	160	1.5	1.0	10	150	2SA1225	2SC2238	
2SA1241	Power amplifier	−50	−2.0	1.0	10	150	2SC3076	**2SA1020	
2SC3076	Power amplifier Strobo flash	50	2.0	1.0	10	150	2SA1241	**2SC2655	
2SA1242	Medium power amplifier	−20	−5.0	1.0	10	150	2SC3072	2SA1120	
2SC3072	Strobo flash Medium power amplifier	20	5.0	1.0	10	150	2SA1242	2SC2270	
2SA1243	Power amplifier	−30	−3.0	1.0	10	150	2SC3073	2SA473	
2SC3073	Power amplifier	30	3.0	1.0	10	150	2SA1243	2SC1173	
2SA1244	Large current switching	−50	−5.0	1.0	20	150	2SC3074	2SA1012	
2SC3074	Large current switching	50	5.0	1.0	20	150	2SA1244	2SC2562	
2SB905	TV vertical deflection output TV Sound output (B class)	−150	−1.5	1.0	10	150	2SD1220	2SA1021	
2SD1220	TV vertical deflection output TV Sound output (B class)	150	1.5	1.0	10	150	2SB905	2SC2481	
2SB906	Low frequency power amplifier	−60	−3.0	1.0	20	150	2SD1221	2SB834	
2SD1221	Low frequency power amplifier	60	3.0	1.0	20	150	2SB906	2SD880	
2SB907	Switching Power amplifier	−40	−3.0	1.0	15	150	2SD1222	2SB677	Darlington
2SD1222	Switching Power amplifier	0	3.0	1.0	15	150	2SB907	2SD687	Darlington
2SB908	Switching Power amplifier	−80	−4.0	1.0	15	150	2SD1223	2SB676	Darlington
2SD1223	Switching Power amplifier	80	4.0	1.0	15	150	2SB908	2SD686	Darlington
2SD1224	Power amplifier	30	1.5	1.0	10	150	–	2SD549	Darlington
2SD1160	Motor control	50 (V_{CES})	2.0	1.0	10	150	–	–	
2SC3075	High voltage power amplifier	400	0.8	1.0	10	150	–	–	

PC* TC = 25°C **TO-92MOD

Transistors (Industrial Use)

Classification Table

Classification			Silicon Transistor (NPN)							
	Ic (Max.)	Pc (Max.)	Basic Product		High Frequency	High Speed	High Voltage	Low Noise	For Governmental Offices	
			Typical Product Description	Classification					NHK Standards	Remarks
Small Power Transistor	~150mA	~400mW	2SC372ⒼTM 2SC2551	2SC372ⒼTM 2SC373ⒼTM 2SC980ⒼTM 2SC980AⒼTM 2SC2551	2SC387AⒼTM	2SC752ⒼTM	2SC780AⒼTM 2SC2551	2SC1000ⒼTM		
	~100mA	~250mW	2SC400 2SC1380	2SC400 2SC979 2SC979A 2SC1380				2SC1380A	2SC587Ⓝ	
	~500mA	~400mW	2SC367ⒼTM 2SC982TM 2SC2550	2SC366ⒼTM 2SC367ⒼTM 2SC982TM 2SC2550		2SC395A			2SC595Ⓝ	
Mendium Power Transistor	100 ~300mA	~750mW	2SC594	2SC507 2SC594			2SC505 2SC506 2SC507		2SC594Ⓝ	
	600 ~800mA	~800mW	2SC108A 2SC503 2SC509ⒼTM	2SC108A 2SC109A 2SC503 2SC504 2SC509ⒼTM		2SC108A 2SC109A	2SC505 2SC506		2SC560Ⓝ	
	~2A	~800mW	2SC510 2SC2655	2SC510 2SC512 2SC2655 2SC3007						
High Power Transistor	1.5~5A	~50W (Tc=25℃)	2SD686 2SD687 2SC522 2SD688 2SD689 2SC2534 2SC2552	2SC522 2SC524 2SD877 2SD686 2SD687 2SD688 2SD689 2SC2562		2SC2534 2SC2552	2SC2534 2SC2552 2SC3148		2SC833Ⓝ 2SC598Ⓝ	
	~7A	~50W (Tc=25℃)	2SC2200 2SC2535 2SC519A 2SD523 2SD633 2SD553	2SC2200 2SC519A 2SC520A 2SC521A 2SD523 2SD633 2SD634 2SD635 2SD553 2SD843		1SC2535 2SC2553	2SC2200 2SC2913 2SC2535 2SC2553 2SD798 2SD799 2SD1088		2SD51Ⓝ 2SD51AⓃ	
	~15A	~100W (Tc=25℃)	2SC1576 2SD524 2SC2790	2SD369 2SC1576 2SD524 2SC2139 2SD867 2SC2555 2SD717 2SD1087 2SD1187		2SC2555 2SC2650 2SC2139 2SC2914 2SC1576 2SD640 1SC2790 2SC2790A 2SC2791 2SC2792 2SC2793			2SD52Ⓝ 2SD52AⓃ 2SD53Ⓝ 2SD53AⓃ	

Classification			Silicon Transistor (NPN)							
	Ic (Max.)	Pc (Max.)	Basic Product		High Frequency	High Speed	High Voltage	Low Noise	For Governmental Offices	
			Typical Product Description	Classification					NHK Standards	Remarks
	15~40A	~300W (Tc=25℃)	2SD552 2SD873 2SD878	2SD552 2SD797 2SD1313 2SD1314 2SD842			2SD641 2SD642 2SD1313 2SD1314		2SD55Ⓝ	
Field Effect Transistor (FET)		Junction	2SK15 2SK112 2SK113 3SK28	2SK11 2SK12 2SK15 2SK48 2SK112 2SK113	3SK28	2SK113 3SK28	2SK112 2SK113	2SK15 2SK48 2SK112 3SK28	2SK12Ⓝ	
		(Dual)	2SK18 2SK72	2SK18 2SK72 2SK18A				2SK18 2SK18A 2SK72	2SK72Ⓝ	
		MOS	3SK38A	3SK38A						
		π-MOS (Power MOS)	2SK324 2SK355 2SK357 2SK386 2SK387 2SK417 2SK419 2SK421	2SK324 2SK325 2SK355 2SK356 2SK357 2SK358		2SK324 2SK355 2SK357 2SK385 2SK387 2SK417 2SK418 2SK420 2SK325 2SK356 2SK358 2SK386 2SK388 2SK419 2SK421				

Classification Table

Classification			Silicon Transistor (PNP)				
	IC (Max.)	PC (Max.)	Basic Product		High Withstand Voltage	Low Noise	NHK Standard
			Typical Product Description	Classification			NHK Standards
Small Power Transistor	~150mA	~400mW	2SA495ⒼTM 2SA1091	2SA495ⒼTM 2SA1091	2SA429ⒼT 2SA1091	2SA493ⒼTM	
	~100mA	~250mW	2SA500	2SA499 2SA500			2SA522Ⓝ 2SA522AⓃ
	~500mA	~300mW	2SA476ⒼTM 2SA1090	2SA476ⒼTM 2SA1090			
Medium Power Transistor	100 ~300mA	~750W	2SA594	2SA594			
	600 ~800mA	~800mW	2SA503 2SA509ⒼTM	2SA503 2SA504 2SA509ⒼTM			
	~1.5A	~800mW	2SA510 2SA1020	2SA510 2SA512 2SA1020			
High Power Transistor	1.5 ~5A	8 ~30W (Tc=25°C)	2SB676 2SB677 2SB502A 2SB434 2SB678 2SB679	2SB502A 2SB503A 2SB434 2SB435 2SB676 2BB677 2SB678 2SB679 2SA1012	2SA739		
	~7A	~50W (Tc=25°C)	2SA656A 2SB673	2SA656A 2SA657A 2SA658A 2SB673 2SB674 2SB675 2SB553 2SB753	2SA739		
	~15A	~100W (Tc=25°C)					
	15 ~40A	~300W (Tc=25°C)	2SB552 2SB833	2SB552 2SB833			

Notes:
1. 3SK38A is MOS FET and others are Junction FETs.
2. ⒼTM:Green transistor for industrial use (TO-92 epoxy package)
   Ⓝ:NHK standards Ⓝ transistor
3. Complimentary transistor
   2SC372 TM,2SC367 TM-2SA467 TM,2SC400-2SA500,2SC503F-2SA503F,
   2SC510F-2SA510F,2SC595Ⓝ-2SA522Ⓝ,2SC560Ⓝ-2SA560Ⓝ,2SC516Ⓝ-2SA516Ⓝ,
   2SC516AⓃ-2SA516AⓃ,2SB502F-2SD102F,2SC519AF-2SC519AF-2SA656AF,2SD552-2SB522
   2SC255-2SA1090,2SC2551-2SA1091 F:Family

Selection Table

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
Low Noise Amplifier	AF (audio frequency)	~100mW		2SA493ⒼTM	2SK12 2SK12Ⓝ 2SK15 2SK48 2SK72	2SC1000ⒼTM 2SC1380A 2SC18 2SK18A 2SK112	Notes: 1Ⓖ : Green transistor for industrial use. Notes: 2Ⓝ: NHK standardsⓃ transistor Notes: 3. *: for UHF.
Low Frequency Amplifier Oscillation	AF (audio frequency)	~100mW	2SA500 2SA522	2S495ⒼTM 2SA499 2SA522AⓃ	2SC400Ⓝ 2SC595	2SC372ⒼTM 2SC373ⒼTM 2SC979 2SC979A 2SC980ⒼTM 2SC980AⒼTM	
		100mW ~300mW	2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ	2SC367ⒼTM 2SC400	2SC366ⒼTM 2SC505 2SC507 2SK112	
	LF (low frequency)	300mW ~3W	2SA509ⒼTM	2SA504 2SA503 2SA510 2SA594 2SA1020	2SC509ⒼTM	2SC503 2SC510 2SC507 2SC594 2SC594 2SC504 2SC2655 2SC3007	
		3W~10W				2SC522	
		10W~		2SA1012 2SA656A 2SB434Ⓖ 2SB435Ⓖ 2SB502A 2SB503A 2SB552 2SB553 2SB833 2SB753		2SC519A 2SD51Ⓝ 2SD52Ⓝ 2SD53Ⓝ 2SD55Ⓝ 2SD234Ⓖ 2SD235Ⓖ 2SD633 2SD640 2SD641 2SC1576 2SD523 2SD524 2SD552 2SD553 2SD843 2SD842 2SC2562	

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
High Frequency Amplifier Oscillation	VHF Amplifier Oscillation	~100mW	2SA500 2SA522	2SA495ⒼTM 2SA499 2SA522AⓃ	2SC400 2SC595Ⓝ 3SK28	2SC372ⒼTM 2SC373ⒼTM 2SC979 2SC979A 2SC980ⒼTM 2SC980AⒼTM	
	HF (high frequency)	100mW ~300mW	2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ 2SA594	2SC367ⒼTM 2SC595Ⓝ	2SC366ⒼTM 2SC507 2SC594 2SC594Ⓝ 2SC383TM 2SC2216 2SK113	
		300mW ~3W		2SA504 2SA503 2SA510 2SA594 2SA1020		2SC503 2SC510 2SC507 2SC594 2SC504 2SC2655	
		3W~		2SA656A 2SA1012	2SC1763 2SC1764 2SC2395 2SC2099 2SC2290 2SC2510	2SC522 2SC519A 2SC2913 2SC914 2SC2790 2SC2552 2SC2553 2SC2555 2SC2650 2SC2652	
VHF Amplifier Oscillation UHF Amplifier Oscillation	VHF UHF	~100mW			3SK28		
		100mW ~300mW	2SA594		2SC387AⒼTM		
		300mW ~3W			2SC998 2SC1001* 2SC1165* 2SC1169 2SC1199* 2SC1765* 2SC1955 2SC2117 2SC2118 2SC2318*		

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
UHF Amplifier Oscillation HF (high frequency)	VHF UHF	3W～		2SA598	2SC2101 2SC2102 2SC2103A 2SC2178 2SC2180 2SC2104* 2SC2105* 2SC2106* 2SC2379* 2SC2380* 2SC2381* 2SC2391* 2SC2420 2SC2638 2SC2639 2SC2640 2SC2641* 2SC2642* 2SC2643* 2SC2782 2SC2783*		

Selection Table

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
DC Amplifier Low Level Amp. Chopper	DC	~100mW			2SK12 2SK12Ⓝ 2SK15 2SD38A 2SK48 2SK72	2SK18 2SK18A 2SC1000ⒼTM 2SC1380A 2SK112 2SK113	Notes: 1. 3SK38A is MOS FET and other are Junction FETs. Notes: 2. Ⓖ : Green transistor for industrial use. (ⒼTM transistor is TO-92 package) Notes: 3. Ⓝ : NHK standards Ⓝ transistor.
Logical Circuit Control Circuit	~100kHz	~100mW	2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA429ⒼTM 2SA499 2SA522AⓃ 2SA1090	2SC400 2SC752ⒼTM	2SC372ⒼTM 2SC780AⒼTM 2SC979 2S979A 2SC980ⒼTM 2SC980AⒼTM 2SC2550	
		100mW ~300mW	2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ 2SA1090 2SA1091	2SC367ⒼTM 2SC400 2SC587Ⓝ 2SC595Ⓝ	2SC366ⒼTM 2SC505 2SC2550 2SC2551	
	100kHz ~1MHz	~100mW	2SA500 2SA522 Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ 2SA1090	2SC372ⒼTM 2SC373ⒼTM 2SC400 2SC595Ⓝ	2SC979 2SC979A 2SC980ⒼTM 2SC980AⒼTM 2SC2550	
		100mW ~300mW	2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ 2SA1090	2SC367ⒼTM 2SC400 2SC595 Ⓝ	2SC366ⒼTM 2SC505 2SC2550	
		300mW ~3W	2SA504	2SA503 2SA510 2SA1020		2SC108A 2SC503 2SC504 2SC507 2SC510 2SC594 2SC594Ⓝ 2SC2655	
	1MHz ~5MHz	~100mW	2SA500 2SA522 Ⓝ	2SA499 2SA522AⓃ	2SC752ⒼTM 2SC400 2SC587Ⓝ 2SC595Ⓝ 2SC372ⒼTMA 2SC373ⒼTMA 2SC395A	2SC979 2SC979A 2SC980ⒼTM 2SC980AⒼTM 2SK112 2SK113	
		100mW ~300mW	2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA499 2SA522AⓃ	2SC395A 2SC400	2SC594 2SC594Ⓝ	
	5MHz ~15MHz	~100mW			2SC752ⒼTM		

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
Power Supply Regulator DC-DC Converter DC-AC Converter	Control DC-DC Converter Oscillation			2SA1020 2SA1012 2SA510 2SA656A 2SB502A 2SB552 2SB553 2SB753		2SC510 2SC522 2SC519A 2SC833Ⓝ 2SC979 2SC2139 2SC2200 2SC2534 2SC2535 2SC2552 2SC2553 2SC3051 2SC3075 2SD51Ⓝ 2SD52Ⓝ 2SD53Ⓝ 2SD55Ⓝ 2SD523 2SD524 2SD552 2SD553 2SD640 2SD641 2SD797 2SD867 2SD873 2SD878 2SD843 2SC2655 2SC2562 2SC2913 2SC2914 2SD717 2SD1187	
	Amplifier			2SA1020 2SA504 2SA503 2SA510 2SA594		2SC503 2SC504 2SC510 2SC594 2SC594Ⓝ 2SC2655	
	Comparator Detecter		2SA467ⒼTM 2SA500 2SA522Ⓝ	2SA495ⒼTM 2SA499 2SA522AⓃ	2SC367ⒼTM 2SC400	2SC372ⒼTM 2SC373ⒼTM 2SC366ⒼTM 2SC505 2SC594	
High Voltage High Power Switch		~100mW		2SA429ⒼTM 2SA1091		2SC780AⒼTM 2SC2551	
		100mW ~300mW		2SA499 2SA522A		2SC366ⒼTM 2SC505	
		300mW ~3W		2SA503 2SA510		2SC503 2SC507 2SC510	
		3W~10W				2SC522	

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			$V_{CEO}<40V$	$V_{CEO}>40V$	$V_{CEO}<40V$	$V_{CEO}>40V$	
High Voltage High Power Switch		~50W		2SA656A 2SA739 2SB434Ⓖ 2SB435Ⓖ 2SB553 2SB834		2SC519A 2SC2200 2SC3148 2SD51Ⓝ 2SD234Ⓖ 2SD235Ⓖ 2SD523 2SD553 2SD633 2SD877 2SD798 2SD799 2SD1088	
		~150W		2SB552		2SC1576 2SC2139 2SD52Ⓝ 2SD53Ⓝ 2SD55Ⓝ 2SD1313 2SD524 2SD552 2SD640 2SD641 2SD797 2SD867 2SD873 2SD878	

Regulator Transistor

System	Type	Maximum Rating *Tc=25°C					Package
		V_{CBO}(V)	V_{CEO}(V)	Ic(A)	*Pc(W)	Tj(°C)	
Switching Regulator	2SC3051	500	400	0.8	10	150	Mold package
	2SC3075			0.8	10		
	2SC2534			2	20		
	2SC2552			2	20		
	2SC2535			5	40		
	2SC2553			5	40		
	2SC2555			8	80		
	2SC2650			10	100		
	2SC2200			7	40		Can package
	2SC2913			7	40		
	2SC2137			7	80		
	2SC2139			10	100		
	2SC2914			10	120		
	2SC2444			30	250		

System	Type	Maximum Rating *Tc=25°C					Package
		V_{CBO}(V)	V_{CEO}(V)	Ic(A)	*Pc(W)	Tj(°C)	
Switching Regulator	2SC3148	900	800	3	40	150	Mold package
	2SC2790/A	850		2	80		Can package
	2SC2791	900		5	100		
	2SC2792	850		2	80		Mold package
	2SC2793	900		5	100		
Series Regulator	2SD880	60	60	3	30	150	Mold package
	2SD1052		50	3	30		
	2SD1052A		50	3	30		
	2SD877	110	80	3	25	175	Can package
	2SD867	130	110	10	100		
	2SD878	100	60	15	115		
	2SD873	160	140	16	150		
	2SD797	100	80	30	200		

Regulator Transistor

Toshiba Supreme Power Transistors

Ic (A)	*VCEO (sus) VCEO (V)	Type		h_{FE}			V_{CE}(sat) MAX(V)			f_T TYP (MHz)	Pc (W) Tc=25°C	Package
		NPN	PNP		V_{CE} (V)	Ic (A)		Ic (A)	I_B (A)			
10	60	2N3713	2N3789	25~90	2	1	1.0	5/4	0.5/0.4	4MIN	150	TO-3
		2N3715	2N3791	50~150	2	1	0.8/1.0	5	0.5	4MIN	150	TO-3
	80	2N3714	2N3790	25~90	2	1	1.0	5/4	0.5/0.4	4MIN	150	TO-3
		2N3716	2N3792	50~150	2	1	0.8/1.0	5	0.5	4MIN	150	TO-3
		TSB3055		20~100	4	4	1.1	4	0.4	8	70	TO-3P
	* 200	2N6249		10~50	3	10	1.5	10	1	2.5MIN	175	TO-3
	* 275	2N6250		8~50	3	10	1.5	10	1.25	2.5MIN	175	TO-3
	* 350	2N6251		6~50	3	10	1.5	10	1.67	2.5MIN	175	TO-3
15	60	2N3055		20~70	4	4	1.1	44	0.4	2.5MIN	115	TO-3
	300	2N6546		12~60	2	5	1.5	10	2	15	175	TO-3
	400	2N6547		12~60	2	5	1.5	10	2	15	175	TO-3
16	140	2N3773		15~60	4	8	1.4	8	0.8	0.2MIN	150	TO-3
20	60	2N3772		15~60	4	10	1.4	10	1	0.2MIN	150	TO-3
	80	2N5303		15~60	2	10	1.0	10	1	2MIN	200	TO-3
	* 75	2N5039		20~100	5	10	2.5	20	5	60MIN	140	TO-3
	* 90	2N5038		20~100	5	12	2.5	20	5	60MIN	140	TO-3
30	40	2N3771		15~60	4	15	2.0	15	1.5	0.2MIN	150	TO-3
	* 40	2N5301	2N4398	15~60	2	15	0.75	10	1	2MIN	200	TO-3
	* 60	2N5302	2N4399	15~60	2	15	0.75	10	1	2MIN	200	TO-3

DC-DC Converter Transistor

LOW V_{CE} (sat) Series

Collector Current Ic (A)	Collector··Emitter Breakdown Voltage V_{CEO} (V)						Collector Power Dissipation *Pc (W)
	20 (V)		50 (V)		80 (V)		
	PNP	NPN	PNP	NPN	PNP	NPN	
12			2SA1328	2SC3345	2SA1329	2SC3346	40
10	2SA1327			2SD717		2SD1187	80
7			2SB754	2SD844			60
			2SB553	2SD553	2SB753	2SD843	40
5			2SA1012	2SC2562			25
	2SA1120	2SC2270					10
2	2SA1300 2SA1160 (V_{CEO}=10V)	2SC3279 2SC2500 (V_{CEO}=10V)	2SA1020	2SC2655	2SA1315	2SC3328	0.9 (Ta=25℃)

*Tc=25℃

Darlington Type Transistor

Ic \ VCEO	30 V	40 V	60 V	80 V	100 V	150 V	200 V	250 V	300 V	350 V	400 V	450 V	600 V	900 V
0.3 A		2SC982TM※												
1.5 A	2SD549※ 2SD1140※				2SB678* 2SB679※ 2SD688* 2SD689※									
3 A														
4 A				2SB676※ 2SD686※										
6 A								2SD1088※	2SD798※		2SD799※			
7 A			2SB675※ 2SD635※	2SD664* 2SB674※ 2SD634※ 2SD523*	2SB673※ 2SD633※									
10 A											2SD685*			
15 A				2SD524*	2SD1087※						2SD641* 2SD683*	2SD683A* 2SD1314*		
30 A				2SB833* 2SD842*		2SD703*	2SD643* 2SD699*			2SD694* 2SD695*	2SC2444*	2SD644* 2SD645*		
40 A									2SD702*		2SD642*			
50 A										2SD696A*		2SD646A* 2SD547*		
100 A												2SD697A	2SD647A*	2SD1165A*
120 A												2SD548*		
200 A							2SD700* 2SD700Ⓓ*							2SD1166*
300 A												2SD1034A*		
400 A									2SD648A*					
600 A							2SD698A*							

* :Can package
※ :Plastic package

☐ Giant transistor is shown in a rectangle.

FET for Commnications Industry (Small Signals)

Type	Application	Structure
2SK11	chopper, switching	N-channel junction type
2SK12	chopper, switching	
2SK15	Low frequency low noise amplifier	
2SK18	Differential amplifier	N-channel junction type (dual)complete separation type
2SK18A	Differential amplifier	
2SK48	Medical equipment	N-channel junction type
2SK72	Differential amplifier	N-channel junction type (dual)complete separation type
2SK112	Low frequency low noise(high gm)	N-channel junction type
2SK113-R	Constant-current, switching	
2SK113-O	Switching, chopper	
2SK113-Y	Analog switch, chopper	
3SK28	Video pre-amplifier	
3SK38A	Chopper circuit	N-channel MOS type (enhancement type)

G-TR Module (Insulated Type)

I_C(A)	$V_{CEO(SUS)}$(V)	Polarity	Structure	Type
±15	450	NPN	Darlington	MG15G1AL2
30	450	NPN	Darlington	MG30G1BL2
±30×2	450	NPN	Darlington	MG30G2CL2
50	450	NPN	Darlington	MG50G1BL2
±50×2	450	NPN	Darlington	MG50G2CL2
±75×2	500	NPN	Darlington	MG75H2DL1
±100	450	NPN	Darlington	MG100G1AL2
±100×2	550	NPN	Darlington	MG100H2DL1
±200	550	NPN	Darlington	MG200H1AL1

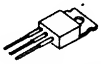
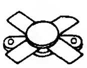
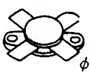
Power MOS FET (π -MOS)

Type	Maximum Rating				Package
	V_{DSX}(V)	V_{GSS}(V)	I_D(A)	P_P(W)	
2SK324	400	±20	10	120	TO-3
2SK325	450	±20	10	120	TO-3
2SK355	150	±20	12	120	TO-3
2SK356	250	±20	12	120	TO-3
2SK357	150	±20	5	40	TO-220AB
2SK358	250	±20	5	40	TO-220AB
2SK385	400	±20	10	120	TO-3P(L)
2SK386	450	±20	10	120	TO-3P(L)
2SK387	150	±20	12	150	TO-3P(L)
2SK388	250	±20	12	150	TO-3P(L)
2SK417	60	±20	10	60	TO-220BS
2SK418	400	±20	2	50	TO-220BS
2SK419	450	±20	2	50	TO-220BS
2SK420	400	±20	5	60	TO-220BS
2SK421	450	±20	5	60	TO-220BS
2SK422	60	±20	0.7	0.9	TO-92MOD
2SK423	100	±20	0.5	0.9	TO-92MOD
2SK405	160	±20	8	100	TO-3P
2SJ115	160	±20	8	100	TO-3P

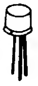
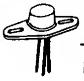
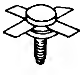
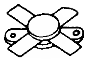
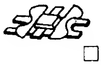
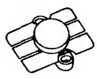
Uni-junction Transistor

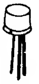
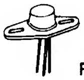
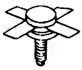
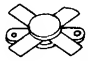
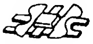
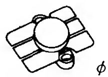
Model	Use	Structure
2SH20	Thyristor gate turn on Timer	SIP emitter planar type
2SH21	Thyristor gate turn on Timer	SIP emitter planer type

RF Power Transistors

	Package Po(W)	 TO-220AB	 φ9.5	 φ12.7
HF/CB 30MHz	3~3.5	2SC1678 2SC2075		
	10~ 12PEP	2SC2098	2SC2395	
	20PEP		2SC2099	
	40PEP			2SC1763*
	60PEP			2SC2290
	80PEP			2SC1764*
	100PEP			2SC2879
	150PEP			2SC2510*
	200PEP			2SC2652**

※ : E−Case
* : Vcc=28V
** : Vcc=50V

	Package Po(W)	 TO-39	 TO-39 Flange	 φ9.5	 φ9.5	 □6.5	 φ12.7
VHF 175MHz	1	2SC994 2SC998※					
	2.5	2SC547	2SC1169※				
	2.8	2SC1955※	2SC2117※				
	5		2SC2118※				
	6			2SC2101		2SC2638	
	15			2SC2102	2SC2178	2SC2639	
	27			2SC2103A	2SC2508		
	32			2SC2420		2SC2640	
	40				2SC2181		
	50						2SC3147
	80						2SC2782

	Package Po(W)	 TO-39	 TO-39 Flange	 φ9.5	 φ9.5	 □6.5	 φ12.7
UHF 470MHz	1	2SC1165 2SC1001					
	2.8		2SC1765				
	3			2SC2104	2SC2391		
	6			2SC2105	2SC2379	2SC2641	
	12			2SC2106	2SC2380	2SC2642	
	25			2SC2173	2SC2381	2SC2643	
	40						2SC2783

RF Power Module

Type	Application	Output Power Po (W)	Frequency Range f (MHz)
S-AV5	10W FM Amateur radio	15	144~148
S-AV6	25W FM Marine radio	28	154~162
S-AV7	25W FM Amateur radio	28	144~148
S-AV8	10W FM/SSB Amateur radio	17	144~148
S-AV9L	5W FM Land Mobile	8	135~155
S-AV9H			150~175
S-AV10L	10W FM Land Mobile	14	135~155
S-AV10H			150~175

Type	Application	Output Power Po (W)	Frequency Range f (MHz)
S-AU3	10W FM Amateur radio	15	430~450
S-AU4	10W FM/SSB Amateur radio	17	430~450
S-AU5L	5W FM Land Mobile	7	400~440
S-AU5M			440~480
S-AU5H			480~512
S-AU6L	10W FM Land Mobile	13	400~440
S-AU6M			440~480
S-AU6H			480~512
S-AU7	10W FM Land Mobile	15	806~825

Condition:V_{CC}, V_{COX}:12.5V, Pi:0.2W

Diodes

Detector & Switching

VR(V) \ IFM(mA)	50~100	300	300~500	750
30	1SS176	1S1555	1S1588 1SS104	
50	1SS177	1S1554 1S2460	1S1586 1S1587	
60		1S1553		
70				1S2095A
80	1SS178		1S1585	
100	1S2091	1S2461	IN4148	
200	1S2092	1S2462		

Type	Use
1S1553 1S1554 1S1555	General Purpose
1N4148 1S1585 1S1586 1S1587 1S1588 1SS176~178	High Speed SW
1S2091 1S2092	High Voltage SW
1S2095A	Hjgh Current SW
1S2460 1S2461 1S2462 1S2463	High Voltage
1SS104	Low Leakage

Zener Diode

List of Zener Diode Products

Vz (V)	250mW Type	500mW Type	1 W Type		5W Type	10W Type
			Epoxy	Metal		
2.0~4.8	02BZ2.2 02BZ2.7 02BZ3.3 02BZ3.9 02BZ4.7	05Z2.0 05Z3.3 05Z2.2 05Z3.6 05Z2.4 05Z3.9 05Z2.7 05Z4.3 05Z3.0 05Z4.7		1S220		1S262
4.8~5.8		05Z5.1 05Z5.6		1S221		1S263
5.8~7.0	(Temperature compensation type) 1SZ57~1SZ59	05Z6.2 05Z6.8	1Z6.2 1Z6.8	1S222		1S264
7.0~8.4		05Z7.5 05Z8.2	1Z7.5 1Z8.2	1S223		1S265
8.4~10		05Z9.1 05Z10	1Z9.1	1S224 1S225		1S266 1S267
10~12		05Z11 05Z12	1Z10 1Z11	1S226 1S227		1S268 1S269
12~14		05Z13	1Z12 1Z13	1S228 1S229		1S270 1S271
14~17		05Z15 05Z16	1Z15 1Z16	1S230~232		1S272~274
17~20		05Z18 05Z20	1Z18 1Z20	1S233~235		1S275~277
20~24		05Z22 05Z24	1Z22 1Z24	1S236 1S237		1S278 1S279
24~29		05Z27	1Z27	1S238 1S239	5Z27	1S280 1S281
29~35		05Z30 05Z33	1Z30 1ZM30 ⁑1Z33	1S240 1S241		1S282 1S283
35~42		05Z36 05Z39	⁑1Z36	1S242 1S243		1S284 1S285
42~50		05Z43 05Z47	1ZM50 ⁑1Z47	1S244~247		1S286~289
50~60		05Z51 05Z56	⁑1Z51	1S248 1S249		1S290 1S291
60~72		05Z62 05Z68	⁑1Z68	1S250 1S251		1S292 1S293
72~86		05Z75 05Z82	⁑1Z75 ⁑1Z82	1S252 1S253		1S294 1S295
86~100		05Z91 05Z100	⁑1Z100	1S254 1S255		1S296 1S297
100~120			⁑1Z110	1S256~258		1S298~300
120~140				1S259 1S260		1S301 1S302
140~170			⁑1Z150	1S261		1S303
170~200			⁑1Z180			
200~400			⁑1Z330 ⁑1Z390			

⁑ :New product

05Z Series (500mW)

Type	Zener Voltage						Measurement Current
	X		Y		Z		
	MIX.	MAX.	MIX.	MAX.	MIX.	MAX.	Iz(mA)
05Z2.0	1.88	2.12			2.05	2.24	10
05Z2.2	2.08	2.33			2.20	2.45	10
05Z2.4	2.28	2.55			2.45	2.70	10
05Z2.7	2.50	2.75	2.65	2.95	2.85	3.10	10
05Z3.0	2.80	3.05	2.95	3.25	3.15	3.40	10
05Z3.3	3.10	3.35	3.25	3.55	3.45	3.70	10
05Z3.6	3.40	3.65	3.55	3.85	3.75	4.00	10
05Z3.9	3.70	3.95	3.85	4.20	4.10	4.40	10
05Z4.3	4.00	4.35	4.25	4.60	4.50	4.80	10
05Z4.7	4.40	4.75	4.65	5.00	4.90	5.20	10
05Z5.1	4.80	5.10	4.95	5.25	5.10	5.40	5
05Z5.6	5.30	5.60	5.50	5.80	5.70	6.00	5
05Z6.2	5.80	6.15	6.00	6.35	6.25	6.60	5
05Z6.8	6.40	6.75	6.65	7.00	6.85	7.20	5
05Z7.5	7.10	7.46	7.34	7.70	7.54	7.90	5
05Z8.2	7.70	8.10	7.96	8.40	8.26	8.70	5
05Z9.1	8.60	9.05	8.85	9.30	9.15	9.60	5
05Z10	9.40	9.90	9.75	10.25	10.10	10.60	5
05Z11	10.40	10.95	10.65	11.20	11.05	11.60	5
05Z12	11.40	11.95	11.70	12.25	12.05	12.60	5
05Z13	12.40	13.10	12.90	13.60	13.40	14.10	5
05Z15	13.90	14.65	14.40	15.15	14.85	15.60	5
05Z16	15.40	16.15	15.90	16.65	16.35	17.10	5
05Z18	16.90	17.80	17.55	18.45	18.20	19.10	5
05Z20	18.80	19.80	19.50	20.50	20.20	21.20	5
05Z22	20.80	21.80	21.50	22.50	22.30	23.30	5
05Z24	22.80	24.00	23.50	24.70	24.40	25.60	5
05Z27	25.1	26.5	26.3	27.7	27.5	28.9	5
05Z30	28.0	29.6	29.3	30.8	30.4	32.0	5
05Z33	31.0	32.7	32.2	33.9	33.3	35.0	5
05Z36	34.0	35.7	35.2	36.9	36.3	38.0	5
05Z39	37.0	38.8	38.1	39.9	39.2	41.0	5
05Z43	39.0	42.0	41.0	45.0	44.0	47.0	5
05Z47	43.0	46.0	45.0	49.0	48.0	51.0	5
05Z51	47.0	50.5	49.5	53.5	52.5	56.0	5
05Z56	51.0					62.0	5
05Z62	56.0					68.0	5
05Z68	62.0					75.0	5
05Z75	68.0					82.0	5
05Z82	75.0					91.0	5
05Z91	82.0					100	5
05Z100	91.0					110	5

Bidirectional Zener Diode

Vz Typical Value (V)	1W Type (Resin Mold Type)	Vz Typical Value	1W Type (Resin Mold Type)
17~24		72~140	⁑1ZM100
24~35	⁑1ZM27	140~200	⁑1ZM180
35~72	⁑1ZM47	200~400	⁑1ZM330 ⁑1ZM390

1ZM30 and 1ZM50 are also available.
⁑ :New product

Variable Capacitance Diode

Tuning

Type	Package	V_R (V)	C_T (pF)		C_T (pF)		Application
				V_R(V)		V_R(V)	
1SV100	Mini	15	450~600	1	20~33	9	AM car radio, portable radio
1SV101		15	28~32	3	12~14	9	FM car radio, portable radio
1SV102		30	360~460	2	15~21	25	AM Hi-Fi tuner
1SV103		35	37~42	3	13.2~16.2	25	FM Hi-Fi tuner
1SV147		15	28.5~32.5	3	11.7~13.7	8	FM car radio, portable radio
1SV149		15	435~540	1	14.9~30.0	8	AM car radio, portable radio
1SV75	1-5G1A	28	26~32	3	4.5~6.0	25	VHF TV tuner
1SV123		30	12.04~13.63	3	2.172~2.454	25	VHF, UHF TV tuner
1SV153	1-2J1A	30	14.16~16.25	2	2.11~2.43	25	VHF, UHF TV tuner
1SV138	1-5G1A	30	26~34	2	2.4~3.2	25	CATV tuner

AFC

Type	Package	V_R (V)	C_T (pF)		Application
				V_R(V)	
1S2094	DO-35	18	7~11	4	VHF、UHF TV AFC
1S2236	DO-35	15	7~14	4	FM tuner AFC

PIN Diode

Type	Package	V_R (V)	I_F (mA)	r_S (Ω)			Application
					I_F(mA)	f(MHz)	
1S2186	DO-35	20	100	1.0Max	10	100	VHF、UHF TV Band SW
1SV99	Equivalent to To-92	50	50	10Max	10	100	Variable ATT、ANT SW、FM AGC
1SV128	Equivalent to TO-236	50	50	7 (TYP)	10	100	VHF、UHF Band SW Variable ATT
1SS155	1-2G1A	30	100	0.9Max	2	100	VHF、UHF TV Band SW

Mixer Diode

Type	Structure	Application
1SS154	Si Epi-pl, Schottky barrier	UHF-C band mixing, detection

Miscellaneuous

Type	Application
1S144	Meter protection
1S2093	Trigger diode triode AC switch turn on

Magnetic Electric Transducer (Hall Effect Device)

Type	Structure	Application
THS102A	Ga-As ion impla planar	Magnetic-electric transducer
THS103A	Ga-As ion impla planar	Magnetic-electric transducer

EXPLANATION

Ratings of Transistors

1. Maximum ratings of transistors

The maximum allowable limits of currents, suppliable voltage, and power dissipation are defined as the maximum ratings for each kind of transistor.

The maximum ratings of transistors are one of the most important factors in determining the effective transistor drive and in expecting sufficiently high reliability of transistor circuits over intended periods of operation.

The most typical characteristic inherent to transistors, diodes, and other semiconductors is the temperature dependency of their electrical properties. Maximum ratings for semiconductors are mostly determined based on a thermal variation of electrical properties. For example, should the ambient temperature be increased while supplying constant voltage to a transistor, such an increase of ambient temperature in turn will increase conductivity of the transistor or current flow in the device. Thus, increased power dissipation of the transistor further raises the device temperature and increases the current. This endless circulation of temperature rise and current increase will finally result in thermal runaway and eventual damage to the device.

Transistor maximum ratings constitute those strict limits which must not be exceeded, in any phase, to assure long service life and high reliability of the transistors. Ratings, which are dependent on materials, structure, design, and fabricating conditions of transistors, differ according to the kinds. In principle, maximum ratings are regarded as absolute maximum ratings.

The term "absolute maximum rating" refers to a value that the operating conditions must not exceed at any phases—even momentarily. Should more than one item be determined as having an absolute maximum rating, neither of them should be applied to the transistor simultaneously.

Should an absolute maximum rating be exceeded, the properties of the transistor may not be recovered in certain instances. When designing a transistor circuit, care must be exercised not to exceed any of the absolute maximum ratings, while taking into account fluctuation of the supply voltage, deviation in properties of the electrical components, exceeding the maximum ratings while adjusting the circuits, variations in ambient temperature, and fluctuations of input signals.

Major items for which maximum ratings must be determined included the emitter, base, and collector currents, voltages between electrodes, power dissipation, junction temperature, and storage temperature of transistors. Because of the close correlation among these properties, none of these ratings can be considered independently of each other; the ratings are largely dependent on external connections.

2. Voltage ratings

Transistors are composed of input and output circuits by using one of the electrodes—namely, emitter, base, or collector —as the common terminal. Consequently, voltage ratings for transistors are rated as collector-to-base voltage (V_{CB}), collector-to-emitter voltage (V_{CE}), or emitter-to-base voltage (V_{EB}).

Breakdown voltages which determine voltage ratings are classified into those inherent to individual transistors ($V_{(BR)CBO}$, $V_{(BR)CEO}$, and so on) and those dependent on input circuit conditions ($V_{(BR)CER}$, $V_{(BR)CEX}$, and so on). Generally, the breakdown voltage is a function of the individual characteristics of the circuit and the transistor.

(1) Voltage ratings of collector

Since transistors are normally used in a common base or in a common emitter mode, ratings for collector voltages are most importance to these operation modes.

Fig. 1 reveals a breakdown of collector voltages in various operation modes; the breakdown voltages shown therein may be defined as follows:

$V_{(BR)CBO}$: maximum collector-to-base voltage with the emitter opened

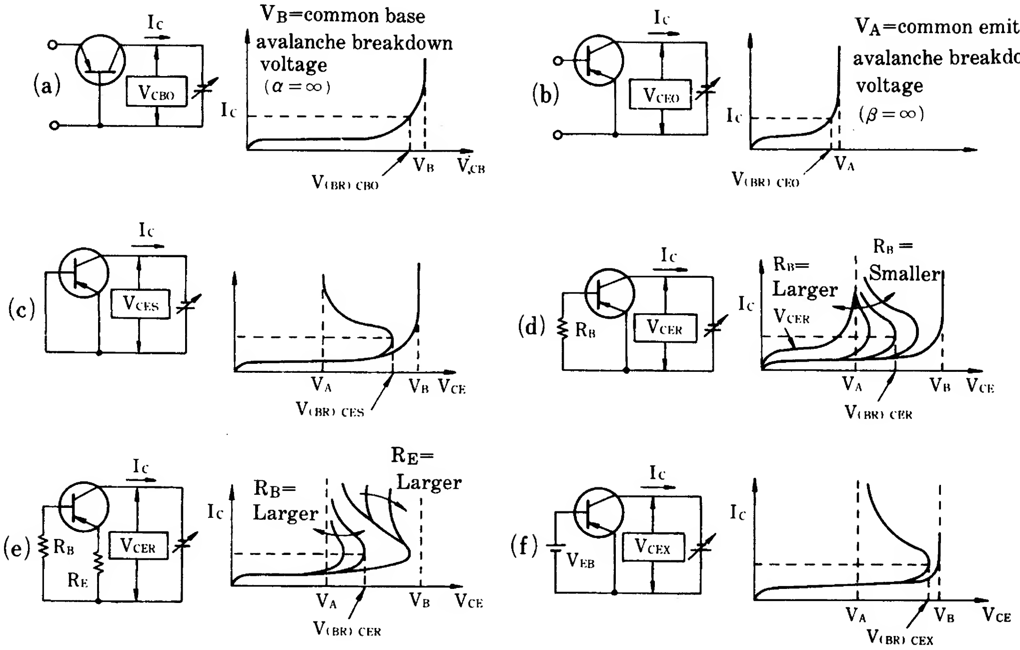


Fig. 1 Maximum collector voltage

$V_{(BR)CEO}$: maximum collector-to-emitter voltage with the base opened

$V_{(BR)CES}$: maximum collector-to-emitter voltage with the emitter and the base short-circuited

$V_{(BR)CER}$: maximum collector-to-emitter voltage with a resistance R between the emitter and the base

$V_{(BR)CEX}$: maximum collector-to-emitter voltage with reverse bias voltage applied between the emitter and the base

When comparing magnitudes of these breakdown voltages, they may be arranged in the following order, although no significant difference is seen between $V_{(BR)CBO}$ and $V_{(BR)CES}$:

$$V_{(BR)CBO} > V_{(BR)CES} > V_{(BR)CEX} > V_{(BR)CER} > V_{(BR)CEO}$$

(a) Maximum collector-to-base voltage with the emitter opened, $V_{(BR)CBO}$

—Common base avalanche breakdown voltage—

Maximum collector-to-base voltage with the emitter opened, $V_{(BR)CBO}$ is equivalent to diode characteristics between the collector and the base. When reverse bias voltage is applied between the collector and the base, small leakage current I_{CBO} flows between them. By increasing such bias voltage, the depletion layer is expanded on both the collector and the base sides. After this process is repeated over and over, in which a small amount of carrier accumulates high energy from this accelerated electric field and collides with Ge or Si atoms to finally produce electrons and holes, a so-called avalanche multiplication phenomenon is produced in which a large amount of free carriers are produced, causing large current to flow rapidly.

This avalanche breakdown phenomenon restricts the maximum suppliable voltage applicable to a transistor.

When avalanche multiplication is present, the multiplication factor M of multiplication in junction-type transistors is experimentally represented by—

$$M = \frac{1}{1-\left(\frac{V_{CB}}{V_B}\right)^n} \quad \cdots\cdots\cdots\cdots (1)$$

The total current amplification factor α is represented by—

$$\alpha = \alpha_0 \cdot M \quad \cdots\cdots\cdots\cdots (2)$$

Where,

V_B= true avalanche breakdown voltage

V_{CB}= voltage applied between collector and base

α_0= common base current amplification factor in voltage where no avalanche multiplication occurs

n= Figure determined by the type of transistor; 3—4 for Ge PNP transistors, 4—7 for Ge NPN transistors, 2—4 for Si PNP transistors, and 2—3 for Si NPN transistors.

V_B is determined by a concentration of impurities on the high resistance side; the higher the concentration, the smaller becomes the V_B.

It is this V_B that definitely determines the maximum value of withstand voltage of a transistor. However, in manufacturers' catalogs, maximum ratings for transistors are usually described by using $V_{(BR)CBO}$ to represent a voltage at which the collector current reaches a predetermined value. In general, the stated value $V_{(BR)CBO}$ is smaller than V_B of the transistor.

The thermal coefficient of V_B is positive because it is related to mobility of a carrier. However, the $V_{(BR)CBO}$ may become smaller in the low-current region at high temperatures, because I_{CBO} rises in accordance with the temperature rise.

When constant input current is supplied to the emitter of a common base transistor, the collector current Ic is—

$$I_C = \alpha I_E + M I_{CBO} \quad \cdots\cdots\cdots\cdots (3)$$

(b) Maximum collector voltage in open-base common emitter connection $V_{(BR)CEO}$ —avalanche breakdown voltage in common emitter connection V_A—

Avalanche breakdown of a common emitter transistor occurs at a collector voltage in which the common emitter current amplification factor β becomes infinite. The factor β can be represented as a function of α_0 and expressed as—

$$\beta = \frac{\alpha_0 M}{1-\alpha_0 M} \quad \cdots\cdots\cdots\cdots (4)$$

The factor β becomes infinite when $\alpha_0 M=1$ or $M=1/\alpha_0$. In other words, as the collector voltage V_{CB} is low, collector current is mostly supplied by the base. But, at a certain collector voltage V_A, which is sufficiently high to create an avalanche phenomenon, the amount of carriers caused by electron multiplication becomes equal to that ($\gamma\beta_0=\alpha_0$) injected from the emitter, due to emitter efficiency γ reaching the depletion layer with the conductivity rate β_0. Base current to support the collector current then becomes unnecessary, or $\beta=\infty$, and avalanche multiplication occurs.

At this point, from $M=1/\alpha_0$ and from equation (1)—

$$\alpha_0 = 1-\left(\frac{V_{CB}}{V_B}\right)^n \quad \cdots\cdots\cdots\cdots (5)$$

In developing equation (5) for the collector voltage or the common emitter avalanche breakdown voltage V_A at which $\alpha_0 M=1$—

$$V_A = V_B \sqrt[n]{1-\alpha_0} \cong V_{(BR)CEO} \quad \cdots\cdots (6)$$

For collector voltages smaller than V_A, base current flows forward; the polarity of β is positive. On the other hand, for voltages larger than V_A, base current flows in reverse; the polarity turns to negative.

The relationship between β and the total current amplification factor α is shown in Fig. 2 as a function of the collector voltage.

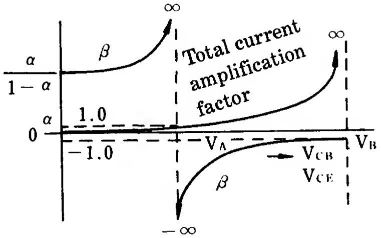


Fig. 2 Current amplification factor and collector voltage

When the input base current is retained constant, collector current I_C of a common emitter transistor is represented by the formula—

$$I_C = \beta I_B + (\beta+1) M I_{CBO} \quad \cdots\cdots\cdots (7)$$

Temperature dependency of $V_{(BR)CEO}$ is determined by that of V_B, α_0, and I_{CBO} (I_{CEO}); the polarity cannot be defined uniformly.

(c) Common emitter voltage rating as a function of circuit configuration—
$V_{(BR)CER}$, $V_{(BR)CES}$, $V_{(BR)CEX}$

When a transistor is operated with a resistor R_B inserted between the base and the emitter, the total collector leakage current MI_{CBO} flows through the internal base resistance r_b and external resistor R_B. When the emitter junction is forward-biased (or when its voltage becomes larger than the contact voltage Vd), emitter injection occurs; also, breakdown occurs between the collector and the emitter. The voltage $V_{(BR)CER}$ at this moment is represented by the equation—

$$V_{(BR)CER} = V_B \sqrt[n]{1 - \frac{I_{CBO}(R_B + r_b)}{V_d}} \qquad (8)$$

V_{CER} is in reverse proportion to R_B; the breakdown voltage takes the largest value when $R_B=0$. When R_B is zero, voltage is expressed as base-to-emitter short-circuit breakdown voltage, or $V_{(BR)CES}$; (See Fig. 1-c)

When the base is opened (or $R=\infty$), operation of the transistor is controlled by β. All of the leakage current MI_{CBO} flows through the base and forms a collector current equal to $(\beta+1)MI_{CBO}$. Breakdown voltage occurs at a collector-to-emitter voltage where $\beta \rightarrow \infty$. This is the voltage previously defined as V_A (common emitter avalanche breakdown voltage).

Breakdown voltage corresponding to other values of R_B is larger than V_A but smaller than V_B. In other words, after emitter injection starts, total current amplification factor ($=\alpha_0 M$) becomes larger than 1, causing β to change to negative. Figure 2 shows that the negative values of β increase with a reduction of V_{CB}, in the region where V_{CE} is larger than V_A. At the breakdown point, emitter injection occurs and Ic increases suddenly. This increase in Ic reduces collector voltage Vc due to a voltage drop across terminal resistance. A decrease of Vc increases β and Ic.

This effect is accelerated accumulatively, and the transistor represents a negative resistance. Vc approximates V_A where $\beta \rightarrow \infty$.

Figure 3(a) reveals the characteristics of R_B and the breakdown voltage; Fig. 3(b) shows the relationship between $V_{(BR)CER}$ and R_B and that between I_{CER} and R_B. These figures represent the same characteristics.

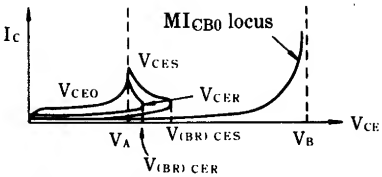


Fig. 3 (a) Characteristics of R_B and breakdown voltage

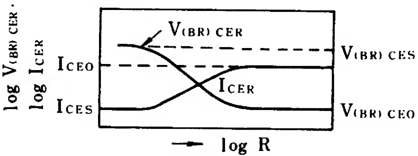


Fig. 3 (b) Characteristics of $V_{(BR)CER}$, I_{CER} and R_B

If R_E is inserted in the emitter side as shown in Fig. 1(e), the negative feedback by R_E increases the avalanche voltage R_A as represented by the equation—

$$V_A' = V_B \sqrt[n]{1 - \frac{\alpha_0 R_B}{R_B + R_E}} \quad \cdots\cdots\cdots\cdots\cdots \quad (9)$$

If the emitter/base is reverse-biased by using V_{EB} as shown in Fig. 1(f), the voltage takes the maximum value when emitter injection occurs, similarly to $V_{(BR)CER}$; it approximates V_A thereafter, displaying negative resistivity characteristics.

The maximum voltage thus obtained, namely V_{CEX}, is obtained by the following formula and is larger than $V_{(BR)CES}$:

$$V_{(BR)CEX} = V_B \sqrt[n]{1 - \frac{I_{CBO} \cdot r_b}{V_d + V_{EB}}} \quad \cdots\cdots \quad (10)$$

(2) Voltage ratings of emitter

Maximum emitter voltage with the collector opened, $V_{(BR)EBO}$, is similar to the above-mentioned $V_{(BR)CBO}$ in terms of essential. However, it is only a few volts in conventional types of transistors because the concentration of impurities is high in the emitter. Unlike the avalanche breakdown previously mentioned, zener breakdown caused by a tunnel effect is produced if breakdown voltage is around 6V or less. Care must be exercised if the base/emitter is reverse-biased at higher voltage; otherwise transistor characteristics will be deteriorated or damaged.

(3) Measuring the voltage ratings

The maximum voltage of a transistor is obtained by measuring the voltage which appears between the specified electrodes when supplying a specified current to specified electrodes under specified conditions. Such measurement is usually effected by regulating the peak current of sinusoidal half-wave to a specified value.

Always refrain from conducting this test by using direct current; otherwise is will thermally breakdown the elements.

3. Current ratings

The current ratings for a transistor include the maximum value of current suppliable in the emitter I_{Emax} forward direction and that which is suppliable in the collector I_{Cmax} reverse direction. Generally speaking, $I_{Cmax} = I_{Emax}$ in most instances. Thus, current ratings are usually determined by duly considering the following items:

(1) Current at which internal power dissipation does not exceed a rated value even though limited collector saturation voltage exists—namely, the current at which junction temperature does not exceed a rated value.

(2) Current at which DC amplification factor h_{FE} is lowered to 1/2~1/3 or less of a peak value—namely for switching purposes, $h_{FE} \cong 10$ for medium-power transistors or $h_{FE} \cong 3$ for large-power transistors.

(3) Current at which internal leads are blown off—The maximum value of the base current I_{Bmax} generally takes the value—$I_{Bmax} \cong 1/2 \sim 1/6 \times I_{Cmax}$.

4. Temperature ratings

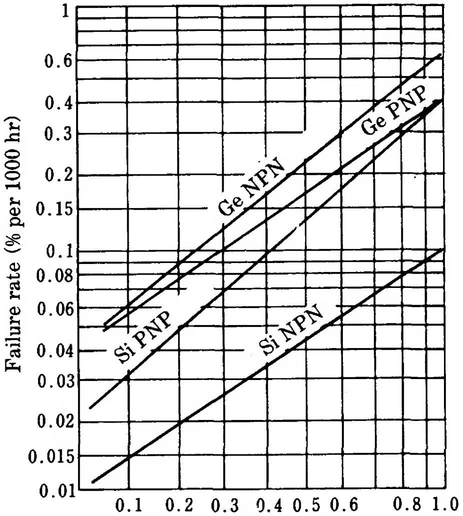
Maximum junction temperature T_{jmax}, specified in accordance with the quality of component materials and their reliability, should be determined by duly considering the characteristics related to reliability (such as deterioration and service life), and not by refering solely to operability.

Generally speaking, transistor deterioration is more accelerated if the junction temperature is higher. The following relationship is found between the average service life Lm (hours) and the junction temperature Tj (°K), with A and B as constants inherent to transistors.

$$\log L_m \doteqdot A + \frac{B}{T_j} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (11)$$

Therefore, the upper limit for allowable junction temperature based on defect ratios and reliability of components is specified for transistors whose long service life must be guaranteed ... 70 ~ 90°C for Ge transistors, 100 ~ 150°C for Si transistors, and 150 ~ 200°C for Si planar transistors whose surface is stabilized.

Storage temperature T_{stg} indicates the temperature range in which a transistor can be stored without causing the transistor to operate. This is also specified according to the quality of component materials and reliability. Fig. 4 reveals the relationship between failure rate and junction temperature of transistors.



Junction temperature Ta regulated by standard temperature To

$$Ta = \frac{Tj - To}{Tj_{max} - To}$$

Fig. 4 Relationship between failure rate and junction temperature of transistors (based on MIL-HDBK-217A)

5. Power ratings

Power dissipated in a transistor is converted into thermal energy which in turn causes a temperature rise.

Internal power dissipation of a transistor operating at a certain operating point is represented by the sum of the collector loss $I_C \cdot V_{CB}$ and the emitter loss $I_E \cdot V_{BE}$. Normally, however, it is determined by the collector loss $P_C = I_C V_{CB} \cong I_C V_{CE}$, since the emitter junction is forward-biased—thereby $V_{CB} > V_{BE}$ and $I_C \cong I_E$.

Major parameters limiting maximum power dissipation P_{CMAX} include the maximum allowable junction temperature T_{jmax} and the standard temperature To (ambient temperature Ta or case temperature Tc); it is well known that these parameters are related to each other in the following manner by thermal resistance θ (or R_{th})

$$P_{Cmax} = \frac{T_{j\,max} - T_O}{\theta} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\ (12)$$

Thermal resistance is a physical value representing the ratio of junction temperature rise per unit-power dissipation—or in other words, a difficulty in exhausting heat. Thus, it is necessary to select a transistor with a large P_{Cmax} to assure large power dissipation. It is very important to rationally design heat radiation in power transistors.

Maximum ratings P_{Cmax} stated in manufacturers' catalogs or other materials generally represent those at normal ambient temperature (Ta = 25°C) or those at Tc = 25°C if use of a radiator is expected. It is possible to obtain thermal resistance between the transistor junction and the environmental temperature, or between junction and case by using former equation (12).

6. Derating

Transistor circuits may be designed by using the maximum ratings of voltage, current, and power (junction temperature) stated in a manufacturer's catalog and by establishing appropriate heat radiating conditions. However, it is a common practice to derate to a considerable extent the operating conditions of high-reliability circuits.

To balance both system reliability and economy, the following derating is recommended:

- Voltage: Voltages at worst operating conditions (including surge voltage) should be 80% or less of maximum rated voltage (especially V_{CEO}).
- Current: Currents at worst operating conditions (including surge current) should be 80% or less of rated value.
- Power: Power dissipation at worst conditions (including surge) should be 50% or less of derated maximum allowable loss at the maximum ambient temperature of equipment.
- Temperature: The operating maximum junction temperature T_{jp} when considering surge and power concentration should be 70—80% or less of the rated maximum junction temperature T_{jmax}.

To calculate the power dissipation of transistors for switching use, the peak values of voltage, current, and power—as well as junction temperature, including surge conditions—must not exceed maximum ratings. However, average power dissipation will sufficiently support system reliability if derating is effected by taking reliability into account.

7. Safe Operating Area (SOA)

The safe operating area represents that area where a transistor retaining high reliability can be used without suffering destruction or deterioration.

Usually, the operating limit of a transistor is determined by its maximum ratings—such as maximum voltage, current, and collector loss. However, when using power transistors in a high-power amplifier or a circuit having an inductive load, deterioration of characteristics or destruction may sometimes result even when they are operated within the maximum ratings. This is caused by secondary breakdown (S/B) of the transistor.

Ever since this phenomenon was first discovered in 1958 by C.G. Tharnton and C.D. Simmons, additional consideration has been required for the concept of SOA, as well as for maximum ratings, when determining the operating limits of a transistor.

It would be very difficult to design high-reliability, economical transistor circuits without properly comprehending the SOA concept as mentioned above.

(1) Secondary breakdown (S/B) phenomenon

As shown in Fig. 5, the secondary breakdown phenomenon further increases current following the primary breakdown. When the current reaches a certain volt-ampere point ($V_{S/B}$, $I_{S/B}$), voltage between the collector and the emitter rapidly drops, descending to a low-impedance area within several microseconds or less, frequently causing destruction of a transistor.

Such a phenomenon may be observed when the base-emitter bias is in a forward or reverse direction, as well as at V_{CEO} or V_{CBO}; If the base bias condition differs, however, the S/B inrush point ($V_{S/B}$, $I_{S/B}$) will vary and align on the locus of the S/B curve shown in Fig. 5. This figure applies to DC. Since the inrush to the S/B possesses an energy dependency, the S/B curve varies in accordance with pulse width of the impressed pulse.

This curve determines an SOA for impressed pulses. Fig. 6 shows the relationship between the pulse width of impressed power and S/B. As the pulse width becomes smaller, the S/B power increases, while the S/B energy decreases. (S/B energy is termed "triggering energy", which implies energy absorbed by a transistor before the energy rushes into the S/B.)

Although various explanations have been given regarding the causes of this S/B, it is generally accepted as an established theory at present that a hot spot is created by a local concentration of current, and causes local thermal runaway. The possible causes for current concentration phenomena are assumed to be a fall of electric potential or instability of laterial temperature distribution in the base area.

Sometimes current will be concentrated when a lack of uniformity of the base width, faulty junction, or unbalanced mounting of the chip on the header material serves as a trigger.

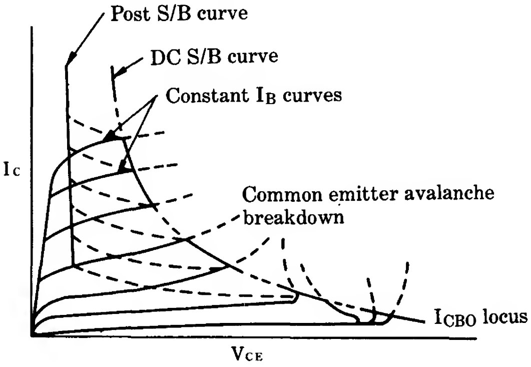


Fig. 5 Collector output characteristics and S/B curve

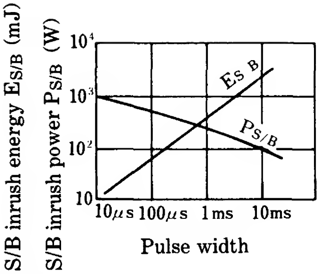


Fig. 6 Relationship between pulse width and $E_{S/B}$, $P_{S/B}$

(2) Forward biased S/B

When forward bias exists between the base and the emitter, a hot spot as a result of local current concentration is created on the emitter periphery.

This is because a fall of electric potential occurs in the base area as a result of the base current immediately flowing laterally below the emitter, and because the emitter periphery is more strongly biased than its center. Therefore, a minority carrier supply to the base is concentrated around the emitter periphery, and the current density rises higher there, as shown in Figs. 7(a) and 7(b).

When this carrier passes through the depletion layer of the collector, it causes a power loss, which leads to local heating, creating a repetition that results in a concentration of current, forming of a hot spot, and S/B.

(Relationship between S/B and transistor characteristics) Current at the inrush point $I_{S/B}$ during the forward bias is closely related to transistor characteristics. When the carrier supplied from the emitter to the base region arrives at the collector junction, it is usually fanned out in a cone-shaped pattern. Therefore, when the transit time of the carrier in the base region becomes longer, the current density becomes lower when it arrives at the collector depletion layer, due to this fan-out effect. And resulting in a hot spot hard to cause. This transit time of the carrier depends on the base width and drift field in the base region. Consequently, $I_{S/B}$ is storongly related to frequency characteristics of a transistor. A negative correlation exists between f_T and $I_{S/B}$ irrespective of the pulse width.

This relationship is shown in Fig. 8 below.

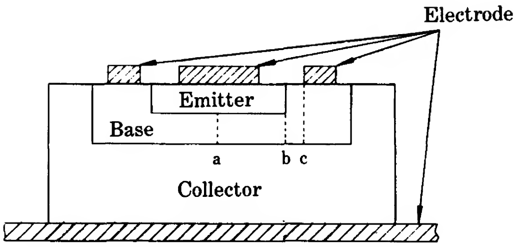


Fig. 7 (a) Planar type transistor

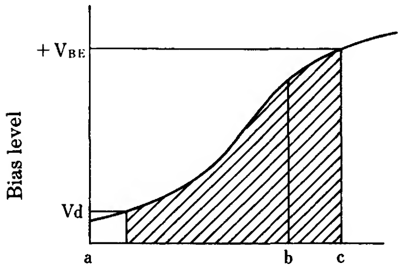
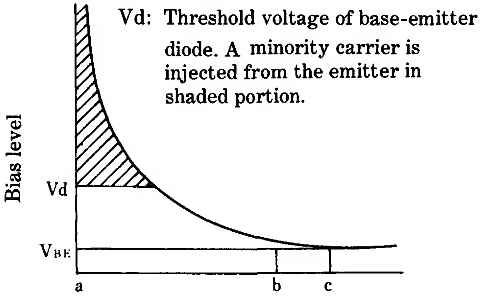
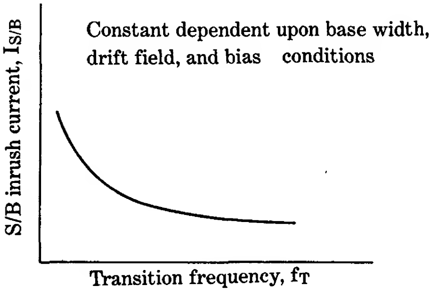


Fig. 7 (b) Emitter voltage (forward bias)



Vd: Threshold voltage of base-emitter diode. A minority carrier is injected from the emitter in shaded portion.

Fig. 7 (c) Emitter voltage (reverse bias)



Constant dependent upon base width, drift field, and bias conditions

Fig. 8 Relationship between $I_{S/B}$ and f_T

(3) Reverse biased S/B

When reverse bias exists between the emitter and the base the direction of a fall of electric potential in the base region becomes contrary to that during forward bias.

Therefore, the carrier supplied from the emitter is concentrated on the center of the emitter. See Fig. 7(c). (The extent of this carrier concentration varies according to the type of transistor. For a ring-shaped emitter, pattern, the carrier concentrates on one point of the emitter center. For a combshaped emitter pattern, it concentrates on one line at the emitter center.)

When reverse bias is higher, the area of concentration at the emitter center becomes smaller. Consequently, triggering energy (energy absorbed by a transistor before it rushes into S/B) during reverse bias becomes far smaller than that during forward bias. The carrier supplied from the emitter, similarly to the case of the forward bias mentioned above, is also fanned out; thus, the base width and the existence of a drift field in the base region are closely correlated with S/B.

Reverse bias S/B occurs mostly in the case of an inductive load. The triggering energy $E_{S/B}$ depends on conditions lying between the base/emitter and the inductance L, as shown in Fig. 9.

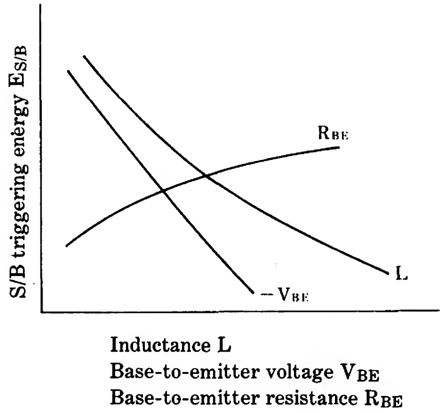


Fig. 9 Dependency of S/B triggering energy $E_{S/B}$ on load inductance and base-to-emitter condition

(4) S/B phenomenon and destruction or deterioration of transistors

Influences of the S/B phenomenon on the electrical characteristics of transistors vary depending on the types of transistors.

If the impressed power is small, or if the power supply is interrupted at the moment S/B occurs, unusual changes may or may not occur in the electrical characteristics, or a transistor may become deteriorated very slowly, even when S/B is caused to occur repeatedly.

Care must be exercised, however, because some transistors are destroyed when they are subjected to S/B just once. Electrical characteristics upon transistor deterioration or destruction due to S/B generally reveal the following aspects: maximum values of V_{EBO}, V_{CBO}, and V_{CEO} usually become lower, or one of them is often short-circuited. Especially, a short circuit between the emitter and the collector indicates a characteristic deterioration of S/B, where a melted spot is formed running from the emitter to the collector. Otherwise, durability against S/B is sometimes reduced even though the electrical characteristics remain unchanged. This is caused by a smaller S/B trigger energy $E_{S/B}$ mentioned above, thereby indicating that the transistor may be easily destructed.

8. Measurement of SOA

Various methods have been proposed for measuring the SOA. Parameters in selecting an appropriate method include circuit configuration, transistor operating conditions, and other factors.

When attempting to directly measure the SOA, in some cases transistors may be deteriorated or destroyed. Thus, for confirming the SOA, it is recommended that the operating conditions of a transistor be measured immediately before the current rushes into the secondary breakdown.

There are three typical methods available for measuring the SOA—

(1) S/B method
(2) Latching method
(3) Transient thermal resistance method

Actual examples of these measuring methods are described subsequently herein.

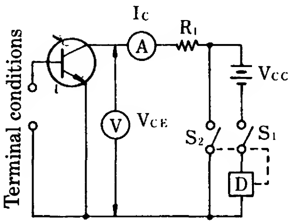
(1) S/B method

This is a methods for actually measuring S/B inrush values by supplying voltage and current between the collector and the base or between the collector and the emitter of a transistor. (See Figs. 10 and 11.)

When applying this methods, a transistor may become deteriorated unless it is mounted in a high-performance protective circuit.

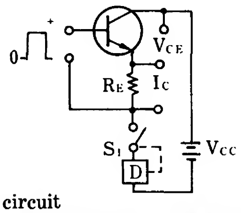
There is another way termed the $T_{S/B}$ method, which is an improved version of the S/B method.

Fig. 12 shows the $T_{S/B}$ method which is a measuring circuit for obtaining a forward-biased SOA when the time of supplied pulse is comparatively long or when using a current similar to DC. A transistor is operated by applying V_{CE} and I_C under a specified temperature (case temperature or ambient temperature) while forward-biasing between the emitter and the base. Measured by this method is the operating time required until I_C fluctuates more than ±10% or exceeds the specified final value. By repeating this measurement to obtain operating time in combinations of I_C and V_{CE}, and by drawing a graph with the operating time as a parameter on the curve of I_C and V_{CE}, the SOA can be obtained.



D: S/B detecting and protective circuit
S1, S2: Switches to be actuated by signals from D

Fig. 10 DC-supplied S/B method.



D: Detecting circuit
S1: Switch to be actuated by the signals from D

Fig. 11 Pulse-supplied S/B method (pulse to be supplied between emitter and base)

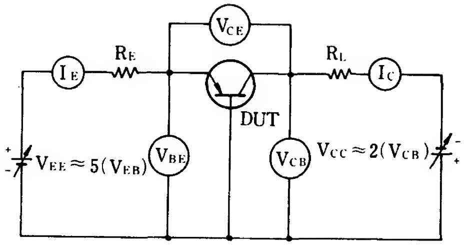


Fig. 12 Forward-biased SOA measuring circuit ($T_{S/B}$ methods)

(2) Latching method

This is a method for measuring the SOA of a transistor by setting it under specified conditions after keeping it in a saturated area under constant current or inductive load conditions.

It is possible to observe oscillation phenomena which occur when the S/B is started by using this method. (Fig. 13)

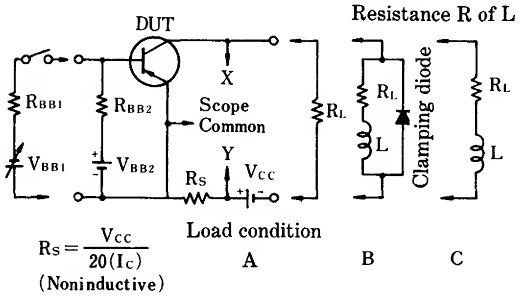
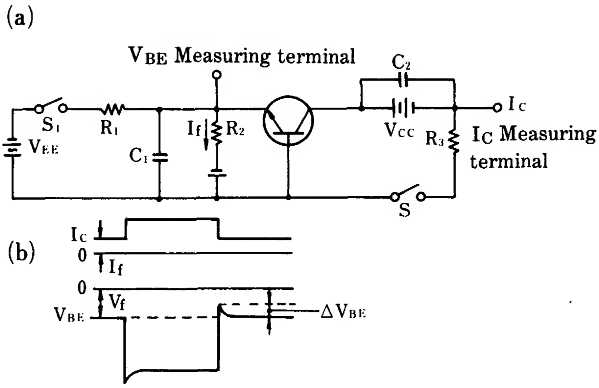


Fig. 13 Reverse-biased SOA measuring circuit (latching method)

(3) Transient thermal resistance method (ΔV_{BE}, ΔV_{CE} method)

Since S/B is regarded as a local temperature rise in the junction of a transistor, the S/B inrush condition can be determined by measuring the junction temperature. Fig. 14 illustrates a typical example. Measure the temperature coefficient of junction forward voltage in advance. The temperature rise in a junction can be obtained by measuring the difference between forward voltage before and after supplying power, transient thermal resistance thus being obtained.



ΔV_{BE}: Temperature drop as a result of power supply suspension

S1, S2: Switches to be actuated depending on conditions of the V_{BE} measuring terminal

Fig. 14 Transient thermal resistance method (ΔV_{BE} method)

This method displays an apparently narrower SOA compared with the two methods mentioned above, and cannot be used to measure reverse-biased SOA.

9. SOA of forward-biased transistors

Fig. 15 and 16 show examples of the SOA of forward-biased transistors.

The SOA implies that the safety operation of a transistor is assured when it is used within the indicated range.

The DC regions of these figures are applied to transistor operations in a DC circuit. A pulse-driven transistor may be used at larger power dissipations as shown in the pulse region of these figures, but safe operation of the transistor is assured only within the given pulse duration.

As shown in Figs. 15 and 16, the lower voltage region shows the thermal resistance limitation while the higher voltage region is limited by S/B. In the thermally limited region, the collector loss Pc is constant and $I=PV^{-1}$; thus, the thermal limitation gradient is -1 when plotted on a logarithmic graph. On the other hand, collector loss in the S/B limited region deviates from the iso-power line of the Pc= constant. The gradient ranges from −1.5 to −4 according to the types of transistors. Note that the relationship of $I_{S/B}=PV^{-N}$ reduces the allowable collector dissipation.

Since the transistor SOA is reduced with a temperature rise, a derating curve shown in Fig. 17 must be used.

When temperature rises, the SOA is far more affected by thermal limitation than by the S/B limitation. Fig. 17 reveals an example of a derating curve for the S/B limitation and the thermal limitation ranges, as a perameter of case temperature. The SOA for transistor 2SA473 shown in Fig. 15 is, at T_C=100°C., rendered as narrow as shown by the dashed lines in Fig. 15. This is because the thermally limited and S/B limited regions are derated by 40% and 49% respectively according to the derating curve shown in Fig. 17 (b). For transistor 2SD526 shown in Fig. 16, where V_{CE} is lower and in the thermally limited region, the derating ratio based on thermal limitation must be considered.

Thermal derating ratio in the S/B limited region differs according to the structure of transistors, as shown in Fig. 17. If V_{CE} is high voltage and within the S/B limited region, derating is effected by using the derating curve of the S/B limitation shown in Fig. 17.

Taking as an example transistor 2SD526, illustrated in Fig. 17, the derating ratio d_T is shown as follows for the thermally limited region provided that the case temperature of the transistor Tc=60°C:

$$d_T=\frac{100}{T_{j\,max}-25}(T_{j\,max}-T_C)\% \quad \cdots\cdots (14)$$

By substituting $T_{j\,max}$=150°C, d_T=72%.

Concerning the derating ratio in the S/B limited region ($d_{S/B}$), 2SD526 must be derated by 50% at 150°C because it is a triple diffused mesa transistor; thus, $d_{S/B}$=2/5 (150−Tc)+ 50%. And $d_{S/B}$ at Tc=60°C is 86%.

In conclusion, it is derated by d_T=72% and $d_{S/B}$=86% at Tc=60°C. This is indicated in Fig. 16 by using dashed lines.

10. SOA of reverse-biased transistors

The SOA of reverse-biased transistors cannot be determined so simply as that of forward-biased transistors. However, the SOA in this direction is as important as that in the forward-biased direction because high collector voltage is supplied frequently to a transistor in an inductance-loaded switching circuit, a horizontal deflection output circuit of TV receivers, or a DC-DC converter, while the base-to-emitter voltage is biased in the reverse direction.

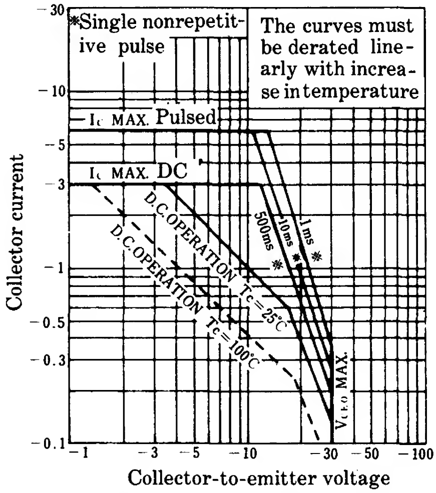


Fig. 15 SOA for 2SA473

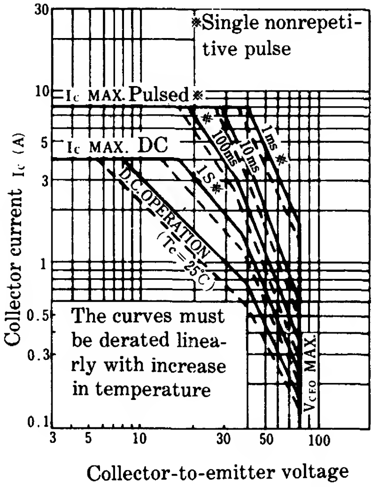
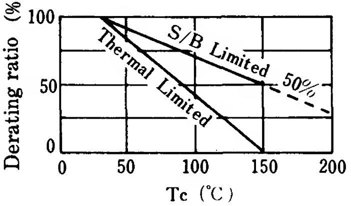


Fig. 16 SOA for 2SD526 and an example of derated SOA at Tc = 60°C

In such operations, the worst load conditions are given by an inductive load. The SOA of reverse-biased transistors is ordinarily ob-

(a) Triple diffused type



(b) Epitaxial type

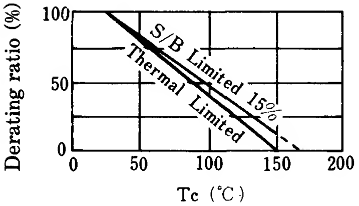


Fig. 17 Thermal derating of the SOA

Note: The above figures shown examples of thermal derating of the SOA for thermally and S/B-limited regions by types of transistor structures.
For a concept of the thermal derating of the SOA, refer to this section on "The SOA of forward-biased transistors."

tained by using the load condition C of the measuring circuit shown in Fig. 13. Fig. 18 (a) illustrates Ic-L curves of a transistor under specified reverse-bias conditions.

Figs. 18 (b) and 18 (c) show the derating of Ic when V_{BB2} and R_{BB2} are changed. It is possible to obtain the SOA for simple L-loaded circuits directly by using the curves shown in Fig. 18. For complicated circuits, however, the effective L must be obtained before utilizing the curves of Fig. 18.

However, plotting a typical SOA for a reverse-biased transistor as shown in Fig. 18 is quite difficult. It is also hard to obtain an effective L accurately from an actual load circuit for users. At Toshiba, the SOA is determined by selecting an adequate Ic, L, R_{BB2}, V_{BB2}, and other data for specific transistor applications and by regarding as defective those transistors whose load characteristics are outside the region shown in Fig. 19 and which display oscillation or partial flickering on the load line.

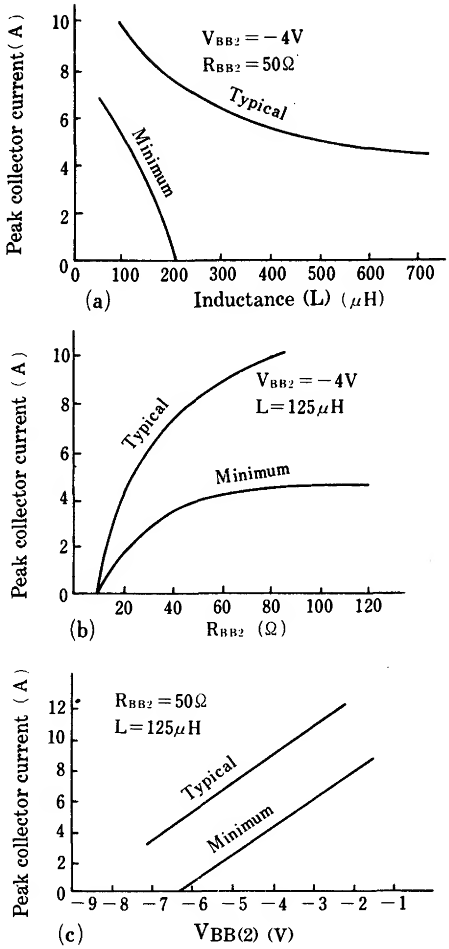
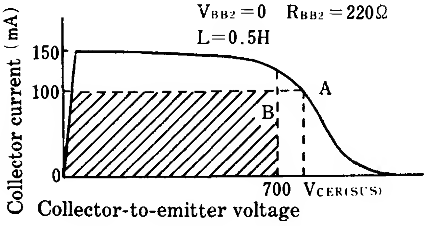


Fig. 18 Examples of SOA for reverse-biased transistors



Measurement is taken at the point (A) above where collector current drops to 100 mA when supplying 150 mA of collector peak current.

Fig. 19 Example of SOA for reverse-biased transistors

Identification System (Transistors, Accessories, and Radiator Holders)

1. Transistors

Example: 2SC 780 A G
1st 2nd 3rd 4th groups

1st group: Represents the types of transistors as shown in the following Table:

1st group	Types of transistors
2SA	PNP transistor, fundamentally high-frequency use
2SB	PNP transistor, fundamentally low-frequency use
2SC	NPN transistor, fundamentally high-frequency use
2SD	NPN transistor, fundamentally low-frequency use
2SH	Uni-junction transistor
2SJ	P-channel field effect transistor
2SK	N-channel field effect transistor

2nd group: Figure starting from 11 (EIAJ number)
3rd group: Suffix denoting modifications in alphabetical order
4th group: Suffix denoting special applications

4th group	Types of special applications
G :	Green transistors for communications and industry applications
D :	Products specially approved by NTT (Nipon Telegraph and Telephone Public Corp.)
N :	Products specially approved by NHK (Japan Broadcasting Corp.)

2. RF Power Amplifier Modules

Example: S – A U 5 L
L: One or two alphabets representing subdivision of frequency
5: Serial No. represents types of modules
U: Symbols representing operating frequency ranges H: HF range, V: VHF range, U: UHF range
A: Represents an amplifier
S: Represents semiconductors

3. GaAs hall sensor

Example: THS 102 A
A: Suffix denoting modifications in alphabetical order.
102: Numerals starting from 101 represent product division
THS: Represents Toshiba Hall Sensor

4. Giant transistor modules

Example: MG 50 G 2 C L 1

- 1 — Serial No.
- L — Symbols representing polarity and structure (L: NPN Darlington; K: NPN Triple Darlington; M: N-ch MOS FET)
- C — Symbols representing circuit structure (Table 1)
- 2 — Numeral showing the number of G-TR
- G — Symbols representing breakdown voltage (Table 2)
- 50 — Collector current (A)
- MG — Symbol representing G-TR module

Table 1

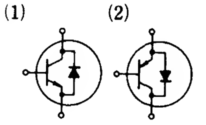
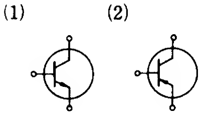
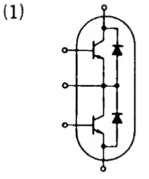
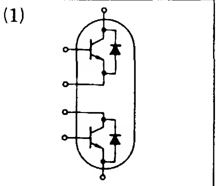
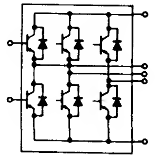
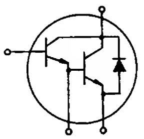
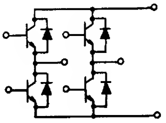
	Circuit structure
A	
B	
C	
D	
E	
Z	Others
F	
G	

Table 2

Char-acters	Max. voltage range (V)	Char-acters	Max. voltage range (V)
Z	25 or more to less than 50	J	600 or more to less than 700
A	50 ″~100 ″	K	700 ″~ 800 ″
B	100 ″~150 ″	L	800 ″~ 900 ″
C	150 ″~200 ″	M	900 ″~1000 ″
D	200 ″~300 ″	N	1000 ″~1100 ″
F	300 ″~400 ″	P	1100 ″~1200 ″
G	400 ″~500 ″	Q	1200 ″~1300 ″
H	500 ″~600 ″		

5. Accessories and radiator holder

Example : AC 23 A
1st, 2nd, 3rd groups
1st group: AC represents accessory
2nd group: Serial number
3rd group: Suffix denoting modifications

Example 2: RH - 16 A
1st, 2nd, 3rd groups
1st group: RH represents radiator holder
2nd group: Serial number
3rd group: Suffix denoting modifications

Thermal Stability and Radiation Design of Transistor Circuit

One of the characteristics of semiconductor products such as transistor and diode is that the electrical characteristic is very susceptible to temperature. Therefore, in circuit design, it is necessary to give consideration to operating temperature and a temperature rise caused by self-dissipation.

For instance, in case the ambient temperature rises in a condition that certain voltage is applied to a transistor, the conductivity of the element is raised and current increases, and thereby the transistor consumes more power and junction temperature rises, thus the current being further increased. This vicious circle leads to a phenomenon that will cause the transistor to be destructed in the end.

Therefore, a design considering changes of operating point caused by changes of temperature is required.

1. Temperature Characteristic of Transistor

(1) Thermal stability

Performance stability factor S is definied by the following expression.

$$S = \frac{\partial I_C}{\partial I_{CBO}} \quad \cdots\cdots (1)$$

That is, this shows a change of collector current I_C when a change was produced in collector cutoff current I_{CBO} by temperature. Among transistor parameters, those that depend most on temperature are leakage current I_{CBO} (I_{CEO}) and base-emitter voltage V_{BE}. These are expressed as function of temperature as follows.

$$I_{CBO(Tx)} = I_{CBO(To)}\, e^{K(Tx-To)} \quad \cdots\cdots (2)$$

$$I_E = I_{CBO}\, e^{qV_{BE}/KT} \quad \cdots\cdots (3)$$

where

To: Reference temperature

Tx: Temperature to be found

K: Temperature coefficient: generally 0.07~0.08/°C when material is silicon

q: Electric charge

k: Boltzmann's constant

T: Absolute temperature

Suppose that the dissipation applied to the junction is Pc and that a variation of ΔPc was produced in this dissipation by some cause. There appears a temperature change of $\Delta Pc\theta_{ja}$ in the junction. (θ_{ja}: thermal resistance from the junction to the open air, which will be described in the following chapter). Consequently, changes are produced in I_{CBO} and V_{BE}. These changes ΔI_{CBO} and ΔV_{BE} cause changes of $S \cdot I_{CBO}$ and $g_m \cdot \Delta V_{BE}$ to collector current.

(The g_m of the transistor is defined by $g_m = \partial I_C / \partial V_{BE}$)

If the variation of the dissipation caused by this change is larger than ΔPc, the temperature will continuously rise. Therefore, this needs to be made small. That is,

$$\Delta P_C \geqq V_C(S\Delta I_{CBO} + g_m \Delta V_{BE}) \quad \cdots\cdots (4)$$

where, Vc: Collector supplied voltage.

Under the above condition, it is considered that stability can be obtained.

Expression (4) is transformed as follows:

$$V_C \cdot S \cdot \frac{\Delta I_{CBO}}{\Delta P_C} + V_C \cdot g_m \cdot \frac{\Delta V_{BE}}{\Delta P_C} \leqq 1 \quad \cdots (5)$$

As $\Delta T = \Delta Pc \cdot \theta_{ja}$ can be considered, expression (2) is differentiated by Pc.

$$\frac{\Delta I_{CBO}}{\Delta P_C} = \frac{\Delta I_{CBO}}{\Delta T} \cdot \frac{\Delta T}{\Delta P_C}$$

$$= K \cdot \theta_{ja} \cdot I_{CBO(To)} \cdot e^{K(Tx-To+Pc\cdot\theta ja)} \quad \cdots\cdots (6)$$

Then, obtain the temperature characteristic of V_{BE} by making emitter current I_E constant in expression (3).

$$\frac{\Delta V_{BE}}{\Delta T} \fallingdotseq \frac{KkT}{q} \fallingdotseq -2.0\times10^{-3}\mathrm{V/°C} \quad \cdots (7)$$

Note:
Generally, −1.8 mV/°C—−2.2 mV/°C can be obtained according to the bias condition of the transistor, but the above −2 mV/°C is usually used as a typical practical value. In Darlington transistor, temperature coefficient becomes twofold, and −4.0—−4.5 mV/°C is used as a typical value, depending on operating conditions.

Consequently,

$$\frac{\Delta V_{BE}}{\Delta P_C} = \frac{\Delta V_{BE}}{\Delta T} \cdot \frac{\Delta T}{\Delta P_C} \fallingdotseq -2.0 \times 10^{-3} \times \theta_{ja} \quad \cdots\cdots (8)$$

Expressions (6) and (8) are substituted for expression (5)

$$V_C \cdot S \cdot K \cdot \theta_{ja} \cdot I_{CBO(To)} \cdot e^{K(Tx-To+Pc \cdot \theta ja)} - 2.0 \times 10^{-3} \cdot \theta_{ja} \cdot V_C \cdot g_m \leqq 1 \quad \cdots\cdots (9)$$

where,

$$Tx - To + P_C \cdot \theta_{ja} \leqq T_{j\,max} - To$$

That is, if expression (9) is satisfied, the circuit is considered to be stable. However, expression (9) is too complicated for practical use. If a change of Ic to the change of V_{BE} is included in the definition of S, the second term in expression (9) can be omitted for practical use. That is, espression (9) is simplified as follows:

$$V_C \cdot K \cdot \theta_{ja} \cdot S \cdot I_{CBO(To)} e^{K(Tx-To+Pc \cdot \theta ja)} \leqq 1 \quad \cdots\cdots (10)$$

where, $Tx - To + P_C \cdot \theta_{ja} \leqq T_{j\,max} - To$

Here, critical voltage V_{crit} is defined as follows.

$$V_{crit} = \frac{1}{K \cdot \theta_{ja} \cdot S \cdot I_{CBO(To)}} \quad \cdots\cdots (11)$$

Expression (11) is substituted for expression (10);

$$\frac{V_C}{V_{crit}} e^{K(Tx-To+Pc \cdot \theta ja)} \leqq 1 \quad \cdots\cdots (12)$$

By transforming the above and making k=0.08, reference temperature (ambient temperature) To=25°C,

$$P_C \cdot \theta_{ja} + T - 25 \leqq 29 \log \frac{V_C}{V_{crit}} \quad \cdots\cdots (13)$$

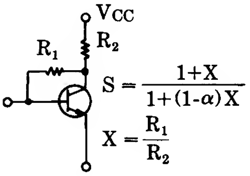
Consequently, expressions (11) and (13) are expressions giving stability conditions of the circuit.

(2) Stability coefficient of bias circuit

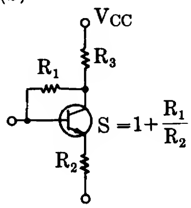
As the stability coefficient of the circuit is described and calculated in various literatures on bias circuit design, only a few examples are mentioned below.

Fig. 1 shows what becomes of the stability coefficient of each bias circuit. (a), (b) and (c) show general bias circuits, and (d) shows a case where direct current resistance of an input transformer can not be ignored.

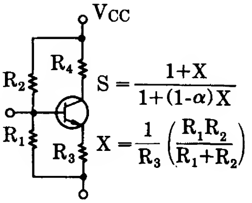
(a)



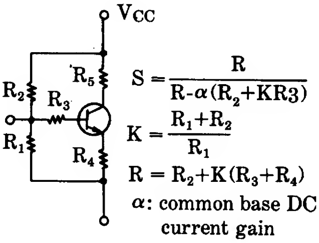
(b)



(c)



(d)



In general, the smaller the stability coefficient is, the better. However, with a small coefficient, the direct current dissipation of the circuit increases, thereby lowering the efficiency.

If the stability coefficient is made small in the bias circuit in output stage, this dissipation is made large, resulting in poor economy.

Therefore, the bias circuit in output stage generally adopts the method of improving thermal stability by a temperature compensating device.

If the temperature compensating device is used, it is possible to optionally select the stability. As the temperature compensating device, thermistor and varister are commonly used.

For the use of them, refer to the catalog for each device. In case thermal stability is completely compensated by the temperature compensating device, it is enough for the transistor to take only the maximum rating of collector power dissipation into consideration.

2. Radiation Design

(1) Maximum allowable power dissipation and radiation equivalent circuit

The maximum allowable power dissipation ($P_{C\max}$) of a transistor, if the thermal stability of the bias circuit described in the previous item is designed to be stable enough, can be given by expression (14), according to the ambient (open air) temperature (Ta) where the transistor is used, its maximum junction temperature ($T_{j\max}$) and the total thermal resistance (θ_{ja} or Rth) from junction to ambient (open air) depending on the radiating conditions to be described.

$$P_{C\max} = \frac{T_{j\max} - T_a}{\theta_{ja}} \text{ (W)} \cdots\cdots\cdots\cdots\cdots (14)$$

$$\left(P_{C\max} = \frac{T_{j\max} - T_C}{\theta_i}\right)$$

For the path conducting the heat generated in the transistor junction to the outside, thermal movement is supposed to be equal to current, and an electric circuit is substituted for convenience's sake. Consequently, it is expressed by thermal resistance and thermal capacitance. In thermally stationary state, it can be shown by the radiation equivalent circuit in Fig. 2.

θi: Internal thermal resistance (from junction to case)

θb: External thermal resistance (from case to ambient)

θs: Thermal resistance of insulating plate

θc: Thermal resistance of contact (in contact with radiating plate)

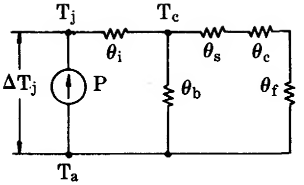


Fig. 2 Radiation Equivalent Circuit

θf: Thermal resistance of heat sink (to the open air)

The total thermal resistance θ_{ja} to the open air, viewed from the junction, is given by expression (15) from the radiation equivalent circuit illustrated in Fig. 2.

$$\theta_{ja} = \theta_i + \frac{\theta_b(\theta_s + \theta_c + \theta_f)}{\theta_b + \theta_s + \theta_c + \theta_f} \cdots\cdots\cdots\cdots\cdots (15)$$

As transistors with middle or lower output generally use no heat sink, θ_{ja} will be:

$$\theta_{ja} = \theta_i + \theta_b \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (16)$$

Though there appears maximum allowable power dissipation of Ta=25°C in catalogs for transistors with middle or lower output, the value given by the following expression with the θ_{ja} given by expression (16) and $T_{j\max.}$ is available.

$$P_{C\max(Ta=25^\circ C)} = \frac{T_{j\max} - 25}{\theta_{ja}} \cdots\cdots\cdots\cdots\cdots (17)$$

The thermal resistance θ_b from the case to the open air depends on the material and con-

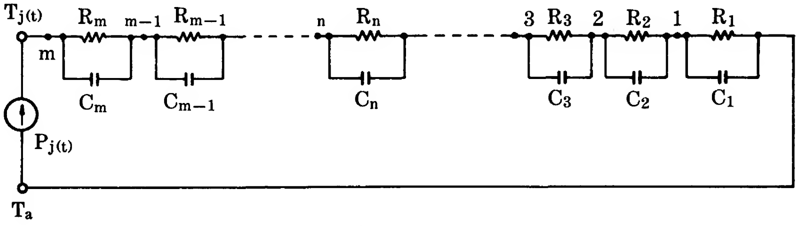


Fig. 3

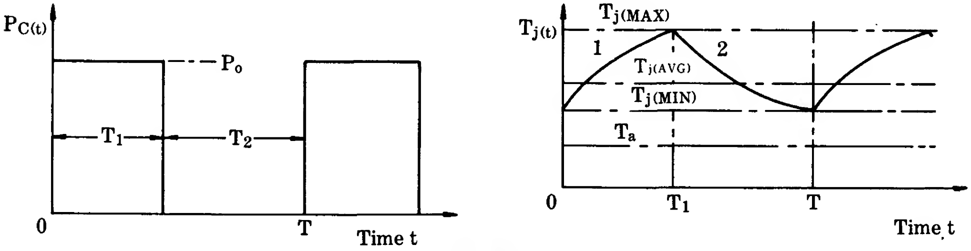


Fig. 4

figuration of the case, but it is a considerably large value as compared with θ_i, θ_c, θ_s and θ_f. Therefore, expression (15) is simplified and the following expression can be used in practice.

$$\theta_{ja} = \theta_i + \theta_c + \theta_s + \theta_f \cdots\cdots\cdots\cdots \quad (18)$$

In dealing with direct current dissipation, it is possible to realize a radiation design satisfying the maximum rating by finding expression (18).

In using transistors in a pulse circuit, etc., great care must be taken so that the peak value of T_j must not exceed T_{jmax}.

(2) Pulse response of junction temperature

In general, the thermal impedance of a transistor is given by such a distributed constant circuit as shown in Fig. 3.

When the pulse dissipation $P_j(t)$ shown in Fig. 4 is applied to the circuit shown in Fig. 3, a temperature change $T_j(t)$ that appears in the mth CR parallel circuit is given by the following expression.

(1) In the region of $P_j(t) = Po$;

$$T_{j(t)} \sum_{n-1}^{m} \{(P_o R_n) - T_{n(min)}\} \times \{1 - \exp(-t/C_n R_n)\} + T_{n(min)} \cdots\cdots \quad (19)$$

(2) In the region of $P_j(t) = 0$;

$$T_{j(t)} \sum_{n-1}^{m} T_{n(max)} \exp(-t/C_n R_n) \cdots\cdots \quad (20)$$

By supposing n=4 for common transistors, it is possible to approximate to the actual value. However, in case the values of C and R are not clear, it is hard to calculate the value of T_j.

Therefore, in general, T_{jpeak} is estimated by using the transient thermal resistance shown below.

Fig. 5 shows the characteristic of 2SC3236 as an typical example of transient thermal resistance characteristic.

When single nonrepetitive rectangular pulse (pulse width T_1, peak value P_0) is applied, the transient thermal resistance $r_{th}(T_1)$ to pulse width T_1 is obtained and T_{jpeak} is given by the following.

$$T_{j\,peak} = r_{th}(T_1) \cdot P_o + T_a \cdots\cdots\cdots \quad (21)$$

When continuous pulses of cycle T are applied, the T_{jpeak} is given by the following expression in thermally stable state.

$$T_{j\,peak} = P_o \left[\frac{T_1}{T} \theta_{ja} + \left(1 - \frac{T_1}{T}\right) \cdot r_{th}(T + T_1) - r_{th}(T) + r_{th}(T_1) \right] + T_a \cdots\cdots \quad (22)$$

The above expression (22) can be applied only in a region where current concentration is not caused by the so-called secondary breakdown.

In the radiation design of pulse circuit, great care must be taken so that the T_{jpeak} in expression (22) may not exceed the T_{jmax} of the transistor.

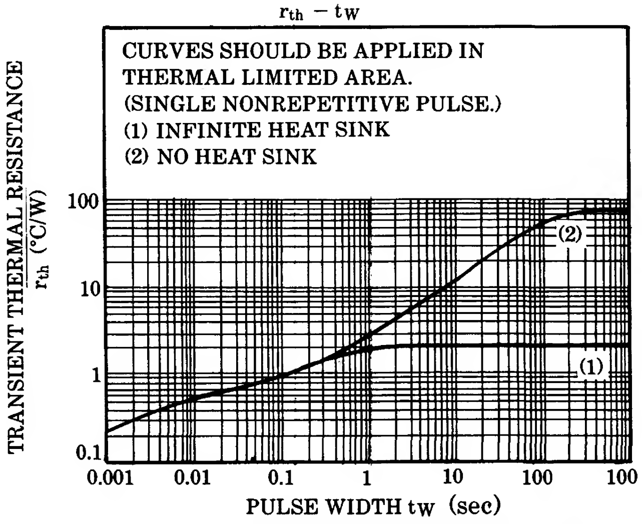
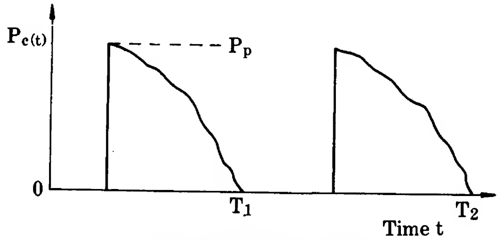
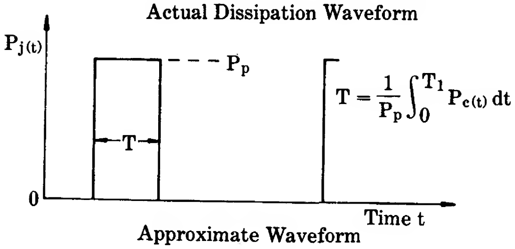


Fig. 5 Transient thermal resistance (2SC3236)

In the above analysis, the rectangular wave is discussed, but in adapting transistors to equipment in practice, $P_j(t)$ may not be a rectangular wave.



Actual Dissipation Waveform



Approximate Waveform

Fig. 6

In such case, by approximating a dissipation waveform to a rectangular waveform, T_{jpeak} can be calculated by expression (22).

3. Thermal Resistance

The thermal resistance in the radiation equivalent circuit shown in Fig. 2 is explained as follows.

(1) Junction-case thermal resistance (internal thermal resistance) θi

The internal thermal resistance θi from transistor junction to case is directly determined by transistor structure, material, mounting methods of the transistor chip to its case and case filler. Therefore, it is the thermal resistance peculiar to individual transistor.

For measuring this value in practice, it is necessary to keep the temperature of the transistor case constant to make a forcedly cooled state.

In case the transistor operates by cooling the case temperature to constant Tc=25°C, the maximum dissipation allowable to the transistor is given by:

$$P_{C\,max} = \frac{T_{j\,max} - T_C}{\theta_i}\ (W)$$
$$= \frac{T_{j\,max} - 25}{\theta_i}\ (W) \cdots\cdots (23)$$

Though there appears Tc=25°C or maximum allowable collector power dissipation in using an infinite heat sink in catalogs for large-output transistors, it is determined by the internal resistance of the transistor, as clarified in expression (14).

(2) Contact thermal resistance θc

Contact thermal resistance θc is determined by the contact state between transistor case and heat sink, and is greatly influenced by plainness of contact surface, its coarseness, contact area and tightness. For example, with silicon grease applied to the surface, an influence by coarseness and plainness can be reduced.

In cases TO-3, TO-66, TO-220, etc., which are designed to be installed directly to heat sink, the contact thermal resistance comes to about 0.5°C/W if grease is applied.

However, in middle or lower output transistors that are not designed to be installed directly because of the miniatualization and economy of cases, the contact thermal resistance comes to a considerable large value depending on installation, when heat sink are used. For improving radiation for middle or lower output transistors, there are radiator holders that enable the transistors to be in-

Table 1 Case-Heat sink Thermal Resistance Value (θc + θs)

Package	Insulating plate	$\theta_c+\theta_s$ [°C/W] Silicon grease Present	Absent
TO-3	No insulating plate Teflon Mica (50~100μ)	0.10 0.70~0.80 0.5~0.7	0.3 1.25~1.45 1.2~1.5
TO-66	No insulating plate Mica (50~100μ) Mylar (50~100μ)	0.15~0.2 0.6~0.8 0.6~0.8	0.4~0.5 1.5~2.0 1.2~1.4
TO-220AB	No insulating plate Mica (50~100μ)	0.3~0.5 2.0~2.5	1.5~2.0 4.0~6.0
TO-220BS	No insulating plate Mica (50~100μ)	0.3~0.5 2.0~2.5	1.5~2.0 4.0~6.0
TO-220IS	No insulating plate	0.4~0.6	1.0~1.5
(TO-3P) 2-16B1A 2-16C1A	No insulating plate Mica (50~100μ)	0.1~0.2 0.5~0.8	0.5~0.9 2.0~3.0
(TO-3P II) 2-34A1A	No insulating plate Mica (50~100μ)	0.1~0.2 0.5~0.7	0.4~0.7 1.2~1.5
(TO-3P(L) 2-21F1A	In insulating plate Mica (50~100μ)	0.1~0.2 0.5~0.7	0.4~1.0 1.2~1.5

stalled effectively to radiators according to their external diameters.

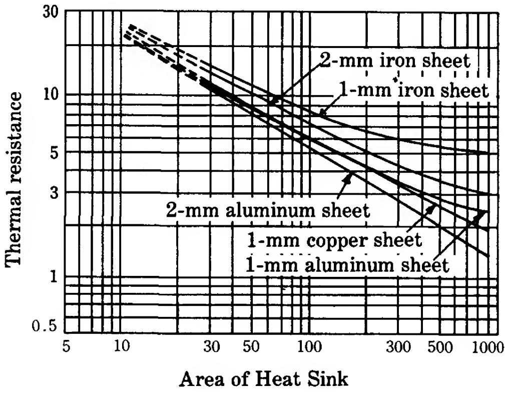


Fig. 7 Area of Heat Sink and Thermal Resistance (θ_f)

(3) Insulating plate thermal resistance θs

In case the transistor needs to be insulated from the radiator, an insulator should be used between the transistor and the radiator. The thermal resistance θs by this insulator is determined by its material, thickness and area, being a value that can not be neglected.

Regarding insulator conductivity, mica is the best and can be used at high temperature, but is hard to make a sheet of insulator with a uniform thickness and has a disadvantage of brittleness. Mylar is inferior to mica in respect of thermal conductivity but can provide uniform and thin insulators.

Generally, the Si transistor has a high junction temperature and adopts mica as insulator.

In these days, silicon rubber is used. This has good thermal conductivity but is hard to thin, so that careful study is required for its application.

When an insulating plate is used, it can not be considered independently of contact thermal resistance, because its thermal contact state is different from that of metal.

The thermal resistance (θc + θs) of each insulating plate including contact thermal resistance is as shown in Table 1.

In design, the sum of contact thermal resistance and the thermal resistance of an insulator plate s considered to be installation thermal resistance (θc + θs). When mica is used and silicon grease is applied, it is appropriate to use 1.0°C/W for TO-3 and TO-66, 3.0°C/W for TO-220, and 1.2°C/W for TO-3P, with some allowance.

(4) Radiator thermal resistance θ_f

Radiator thermal resistance is considered to be distributed-constant thermal resistance of the path by which heat escapes from the radiator surface to the open air.

This is related with the state of the open air, the temperature difference between radiator and the open air and the useful area of the radiator and is hard to express by a numerical expression. At present, this is totally determined by actual measurement.

Fig. 7 shows the actual thermal resistance value measured with the radiator set in a vertical position when a transistor is installed in the center of the radiator.

In recent years, radiator manufacturers have been manufacturered various radiators, it will be convenient to refer to their data for practical use.

For accessories necessary for installing the power transistor to the radiator and installation method, refer to the item "Accessories"

4. Calculation Example for Radiation Design

On the basis of the data described heretofore, an actual calculation example is shown. The constants to be given or obtained in calculation are classified into 4 as follows.

(a) Transistor (θi,T_{jmax})
(b) Power dissipation of transistor (P_{dc})
(c) Ambient temperature (Ta)
(d) Radiator thermal resistance (θ_f)

(1) With transistor, ambient temperature and power dissipation given, a radiator is found.

Example 1 :

Giving power consumption P_{dc}=15W to 2SD1187, find a radiator necessary to permit operation up to ambient temperature Ta=60°C.

According to the catalog of 2SD1187, the given conditions are P_{cmax}=80W (Tc=25°C), T_{jmax}=150°C, P_{dc}=15W and Ta=60°C.

If mica is used for insulation and silicon grease is applied, θc + θs = 0.8°C/W.

From expression (14),

$$\theta_i = \frac{T_{j\,max}-T_C}{P_{C\,max}} = \frac{150-25}{80} \doteqdot 1.6^\circ C/W$$

$$\theta_{ja} = \frac{T_{j\,max}-T_a}{P_{dc}} = \frac{150-60}{15} = 6^\circ C/W$$

Consequently, from expression (18),

$$\begin{aligned}\theta_f &= \theta_{ja}-(\theta_i+\theta_c+\theta_s)\\ &\doteqdot 6-(1.6+0.8)\\ &= 3.6^\circ C/W\end{aligned}$$

A radiator whose thermal resistance is under 3.6°C/W is necessary. With a 2-mm-thick aluminum sheet, an area of 200 cm^2 is required from Fig. 7. Therefore, an aluminum heat sink with dimensions of 140×140×2 mm is used.

(2) With transistor, ambient temperature and radiator given, the maximum power dissipation allowed to the transistor is found.

Example 2:

When 2SC3258 is to be installed on an aluminum heat sink with dimensions of 100×100×2 mm, being insulated by mica, and to be operated up to ambient temperature Ta=60°C, find the maximum power dissipation allowed to the transistor.

According to the catalog, the given conditions are P_c=30W (Tc=25°C), T_{jmax}=150°C and Ta=25°C, and from Fig. 7, θ_f=5.4°C/W or $\theta c + \theta s$ = 3°C/W.

First, from expression (23),

$$\theta_i = \frac{T_{j\,max}-T_C}{P_{C\,max}} = \frac{150-25}{30} \doteqdot 4.2^\circ C/W$$

Consequently, from expression (18),

$$\begin{aligned}\theta_{ja} &= \theta_i+\theta_c+\theta_s+\theta_f\\ &= 4.2+3+5.4\\ &= 12.6^\circ C/W\end{aligned}$$

$$\begin{aligned}P_{dc} &= \frac{T_{j\,max}-T_a}{\theta_{ja}}\\ &= \frac{150-60}{12.6}\\ &\doteqdot 7.1W\end{aligned}$$

That is, the maximum power consumption of 7.1 W is allowable.

(3) With transistor, radiator and power consumption given, the maximum ambient temperature permitting operation is found.

Example 3:

When 2SD797 is to be installed on an aluminum heat sink with dimensions of 100×100×2 mm, being insulated by mica (silicon grease is applied), find the maximum ambient temperature permitting operation with the maximum power dissipation of 15 W.

According to the catalog, the given conditions are P_{cmax}=200W (Tc=25°C), T_{jmax}=175°C and from Fig. 7, θ_f=5.4°C/W or P_{dc}=15W, and $\theta c + \theta s$ = 1°C/W.

First, from expression (23),

$$\theta_i = \frac{T_{j\,max}-T_c}{P_{c\,max}} = \frac{175-25}{200} = 0.75^\circ C/W$$

From expression (18),

$$\begin{aligned}\theta_{ja} &= \theta_i+\theta_c+\theta_s+\theta_f\\ &= 0.75+1+5.4\\ &\doteqdot 7.2^\circ C/W\end{aligned}$$

From expression (14),

$$\begin{aligned}T_a &= T_{j\,max}-\theta_{ja}\cdot P_{dc}\\ &= 175-7.2\times15\\ &= 67^\circ C\end{aligned}$$

That is, the maximum ambient temperature permitting operation is 67°C.

5. Radiation Design Considering Reliability

The fundamental conception and calculation for thermal stability and radiation in transistor circuit design have already described.

Now, it is necessary to consider the conception about reliability. Particularly, for communication equipment and equipment using numerous parts per unit, derating is required in consideration of reliability.

Generally, the degradation of a transistor has the relation of exponential function with junction temperature. An one-figure (tenfold) improvement of reliability is expected by derating of 40–50°C with difference among individual kinds of transistor. In case high reliability is needed, it is necessary to keep junction temperature (temperature rise by applied voltage + ambient temperature) as low as possible.

A sudden change of junction temperature is caused by switching on and off of equipment, and its repetition gives rise to thermal fatigue of the electrode junction within the transistor. As a result, a long life may not be expected.

In order to avoid this, sufficient derating is required for junction temperature and its change.

A calculation example of the radiation design considering reliability is shown in Example 4.

Example 4:

When 2SC524 is operated at the maximum ambient temperature of 55°C with power dissipation of 3 W, let's find the necessary heat sink size.

According to the catalog of 2SC524, the given conditions are $P_{cmax}=10W$ ($T_c=25°C$) and $T_{jmax}=175°C$.

First, from expression (19),

$$\theta_i = \frac{T_{j\,max}-T_c}{P_{c\,max}} = \frac{175-25}{10} = 15℃/W$$

For performing high reliable design, the maximum operating junction temperature is derated by 50°C, and the maximum operating junction temperature is:

$$T_{j\,(op)\,max} = 175-50 = 125℃$$

From expression (17),

$$\begin{aligned}\theta_{ja} &= \frac{T_{j\,(op)\,max}-T_{a\,max}}{P_{dc}}\\ &= \frac{125-55}{3} \fallingdotseq 23.3℃/W\end{aligned}$$

Consequently, with $\theta c + \theta f = 1°C/W$ and from expression (18),

$$\begin{aligned}\theta_f &= \theta_{ja}-(\theta_i+\theta_c+\theta_s)\\ &= 23.3-(15+1)\\ &= 7.3℃/W\end{aligned}$$

A radiator whose thermal resistance is less than 7.3°C/W is required. From Fig. 7, an aluminum heat sink with dimensions of 80×80×2 mm is appropriate.

In this design, as compared with the design at maximum rating, an approx. two-figure (centuple) improvement of reliability is expected in the case of operation at an ambient temperature of 25°C, and an approx. 1-figure (tenfold) improvement of reliability can be expected even in the case of operation at the worst temperature of 55°C.

Precautions on Utilizing Transistors

It is necessary to carefully handle semiconductor products when operating them, especially when carrying or mounting them. The following refers to notes on handling transistors.

1. Mounting on a heat sink

Power transistors sometimes require heat sinks depending on the source voltage, current load conditions, and ambient temperature. In such a case, the following attentions must be paid so that the heat sink effect is maximized and the transistors are subjected to minimum stress.

(1) Coating with silicon grease

Coat the silicon grease between the transistor and the heat sink to optimize thermal resistance between them. Coat the silicon grease thinly and uniformly.

It is recommended for using a nonvolatile silicon compound. (Should a volatile compound be used, the grease may be cracked in the long run, thus degrading the heat sink effect.)

In some cases where silicon grease is applied to plastic package-type transistors, the base oil contained in the silicon grease may be separated and permeate in the transistor interior, extremely shortening transistor life time. Be careful when selecting the type of silicon grease.

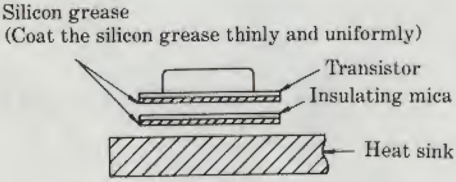


Fig. 1 Coating the silicon grease

Silicon Grease YG6260, produced by Toshiba Silicon Co., is recommended for this purpose. Its base oil is seldom separated, so that it does not affect the transistor life time.

This notice is not applicable to metal-sealed transistors.

(2) Mounting accessories for tightening screws and nuts

It is recommended following the mounting procedures shown in Fig. 2 (TO-3, Toshiba 2-21D1A), Fig. 3 (TO-66, Toshiba 2-13A1A) and Fig. 4 (TO-220 AB, Toshiba 2-10A1A), so that transistors are electrically insulated from the heat sink and thus increase the heat sink effect.

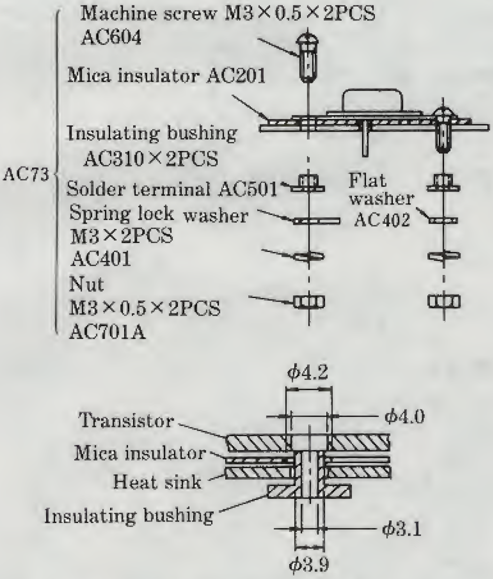


Fig. 2 Mounting transistor TO-3 (2-21D1A) on a heat sink

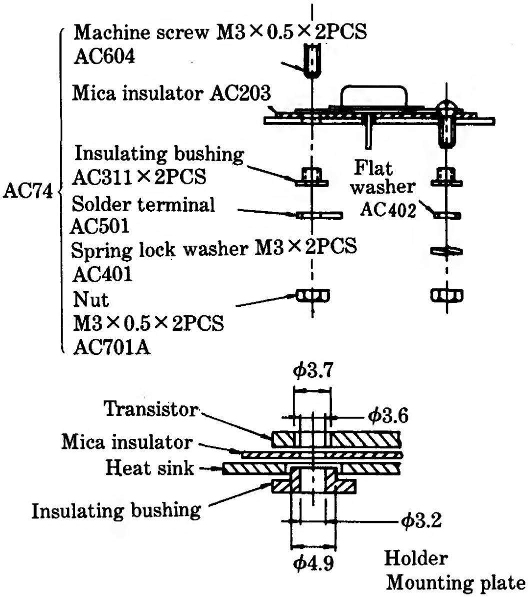


Fig. 3 Mounting transistor TO-66 (2-13A1A) on a heat sink

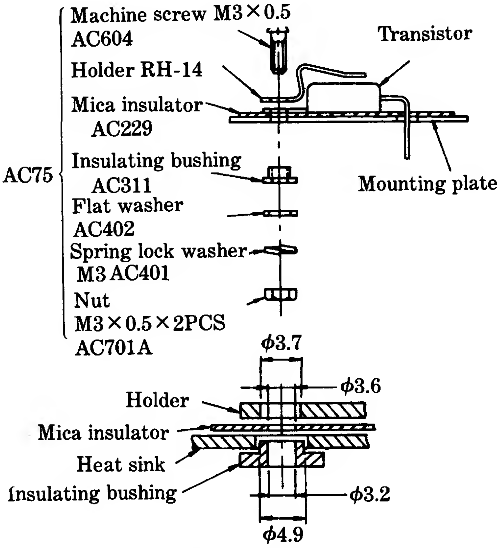


Fig. 4 Mounting transistor TO-220AB (2-10A1A) on a heat sink

(3) Screw tightening torque

Should a screw be tightened with excessive tightening torque, it may be wrenched off or the transistor system may be strained or damaged.

Fig. 5 illustrates relations between screw tightening torque and thermal resistance. Should a certain value of torque be exceeded, thermal resistance becomes saturated.

It is recommended to force below following the tightening torque so that optimum thermal resistance is assured and the transistor is freed from stress, mentioned below (Table 1).

Table 1 Recommended screw tightening torque

Outline		Screw tightening torque (MAX.)
JEDEC	Toshiba product No.	
TO-3	2-21D1A	8kg·cm
TO-66	2-13A1A	6kg·cm
TO-220AB	2-10A1A	6kg·cm
TO-126	2-8F2A	4kg·cm
—	2-16B1A	8kg·cm
—	2-34A1A	8kg·cm

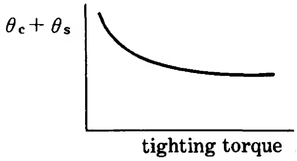


Fig. 5 Relations between screw tightening torque and thermal Resistance

When using a pneumatic screwdriver, it is necessary to control the tightening torque so that its maximum value falls within that listed in Table. 1

(4) Stress on transistor electrode leads

If excessive stress is applied to a transistor electrode lead, the internal connection of wires may be damaged. Especially as to plastic-packaged transistors, keep the stress below 1kg, as shown in Fig. 6.

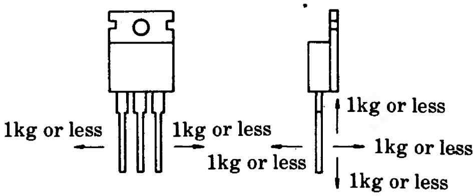
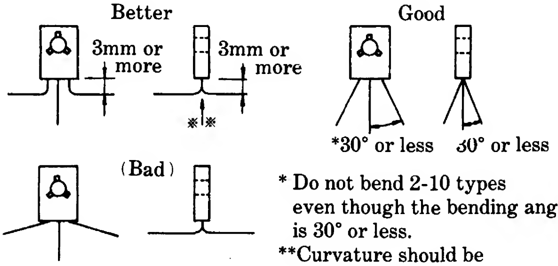


Fig. 6 Stress to electrode leads

(5) Lead Bending

Lead bendings are shown in Fig. 7 if they are require.



* Do not bend 2-10 types even though the bending angle is 30° or less.

**Curvature should be 1mm or more when bending the leads.

Fig. 7 Lead bending (common to 2-8F1A and 2-10A1A)

2. Electrostatic breakdown

Each transistor has its own maximum rating. The circuits are designed so that excessive voltage and current will not be applied. However, transistors are sometimes damaged before they are actually mounted on circuit boards. This is often resulted by overvoltage breakdown before mounting transistors. It is caused by static electricity produced by a charged human body or packing materials.

For instance, clothes made of chemical fiber which are worn daily are particularly charged with static electricity. Everyone experiences a static electricity "crackling" sound when they take off a coat on a fine and dry day. These values are known from experiments to be from around several kV to tens of kV as listed in Table 2.

Table 2 Voltage electrified by clothing friction (kV)

Static electricity in the human body immediately after removing a work uniform after strongly rubbing against one's underclothing.
(Ambient conditions: 25°C, 25% RH, Unit: kV)

Underclothing / Work uniform	Cotton	Wool	Acryl	Polyester	Nylon	Vinylon + cotton
Cotton 100%	1.2	0.9	12	15	1.5	1.8
Vinylon/cotton (55%/45%)	0.6	4.5	12	12	4.8	0.3
Polyester/rayon (65%/35%)	4.2	8.4	19	17	4.8	1.2
Polyester/cotton (65%/35%)	14	15	12	7.5	15	14

It has been confirmed that such static electricity leads a transistor to overvoltage breakdown, when applying it to the transistor through its electrode. Although this voltage differs substantially depending on ambient conditions, such voltage will sometimes cause an unexpected breakdown in MOS FETs or high-frequency transistors which are rather easily affected by excessive voltage.

Therefore, take care of handling such transistors as follows.

(1) When storing transistors, it is recommended short-circuiting between electrodes with conductive materials, or to pack the entire transistor with aluminum foil or similar material.

Avoid storing or transporting transistors in nylon or plastic containers which are easily charged static electricity.

(2) When handling transistors, it is necessary to safely discharge static electricity in the ambient environment; for example, by grounding easily charged things on a desk or a human body. (Note)

Note: To ensure human safety, be sure to ground an employee's body through a resistance of 10MΩ or so, rather than directly grounding.

(3) As far as possible avoid using work uniforms of chemical fiber, nylon gloves, and similar fiber.

(4) When mounting transistors for a printed circuit board (PCB), the board often constitutes a high-impedance circuit if it is without being additionally processed.

Since it sometimes happens to apply overvoltage on transistors, it is recommended short-circuiting the electrodes of a PCB with each other in the same manner as when storing transistors.

(5) Although this is not caused by static electricity, when soldering transistors, be careful as to leakage from the soldering iron. It is necessary to protect the transistor from suppling voltage to the solder. It is advisable to ground the tip of the soldering iron through substantially low resistance.

3. Soldering

(1) Soldering temperature

When soldering a transistor onto a printed circuit board, 6/3 solder is usually used. When using this type of solder, it is expected that temperature of the soldering bath (such as flow solder) is about 240—260°C and that of the soldering iron is, 300°C or more.

Maximum rating for storing temperature of a transistor is usually from −55° to +125°C or from −65° to +175°C. It is preferable to solder transistors in as short a time and at as low temperature as possible.

Generally it is necessary to maintain a soldering temperature, 260°C and to shorten the soldering time to less than 10 seconds, except for specially designed transistors.

Even when considering use of a soldering iron, it is necessary to maintain 350°C and 3 seconds or less. It is also recommended that when using a soldering iron, pincettes or pinchers be employed to let heat escape from the transistor main body.

(2) Soldering procedures

As mentioned above, it is necessary that heat being transferred to a transistor be minimized when soldering it.

It is necessary to separate the transistor main body from a printed circuit board or to form its leads in such a manner as to lighten the stress from being applied to the main body, as shown in fig. 8 below.

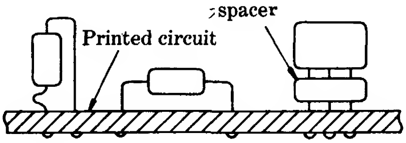


Fig. 8 Example of soldering method

(3) Cleaning method

To remove flux, cleaning is often conducted after soldering transistors to printed circuit boards. This cleaning often involves a cleaning agent for removing flux or an ultrasonic wave cleaning method. Since the outline and markings of semiconductor devices are very delicate, it is necessary to carefully select such solvents. It is recommended using freon-type solvents such as Freon TE and Dai-Freon Solvent S3-E.

When using an ultrasonic wave cleaning method, stress applied to a transistor differs substantially depending on the cleaning bath size, vibrator output, and resonance among devices. Therefore, it is recommended avoiding the use of an ultrasonic wave cleaning method for hollow transistors. However, if use of that method is unavoidable, it is necessary to position the main body of transistors in location not directly exposed to a vibrator and to reduce cleaning time to less than 30 seconds, so that no stress is applied to the main body of transistors.

Reliability of semiconductors

1. Quality assurance program

The quality and reliability of semiconductor elements are closely related and important to our daily lives as well as to industrial equipment.

In this section is explained the quality assurance program as shown in Fig. 1 and Table 1, including the ATS (Approval Test System) in which severe approval tests are defined for each stage of processes from planning through mass production when developing a new item, as well as the maintenance service after delivery of semiconductors.

(1) Development stage

The quality and reliability of semiconductor products are highly dependent upon the designing of element structures. In this stage, the designing, production technology, applied technology, and quality assurance departments and sections cooperate in deliberating on basic design, production processes, and quality and reliability, as well as market research.

Some examples of specific jobs in this stage include setting reliability goals, research on past data, checking design criteria, and establishing estimating methods and criteria considering application. After clearly solving these problems, the development and trial production are started.

In the development and trial production process, both electrical properties and reliability goals are checked and confirmed as to whether or not they have reached the levels initially established.

In this stage, production technology, especially processes peculiar to each product is estimated and confirmed. After quality and reliability are confirmed, a subsequent trial run for mass production is initiated.

In the trial run stage for mass production, are priority is given to the stability of production process estimates.

In this stage, it is important to check whether reliability confirmed in the development and trial run stage are constantly maintained in a stabilized condition. The ability of production processes is confirmed and priority items are established to realize ideal process control, thus paving the way for subsequent mass production.

(2) Mass production stage

To maintain quality and reliability in the development stage for mass-produced items and to continue stable production with least variations, it is essential that the production process be stabilized, that quality control be thoroughly effected, and that the quality of parts and materials be stabilized.

Toshiba has established QCS (Quality Control Standards) with top priority on in-process quality control, based on the basic policy that "the production process plays the main role in assuring quality and reliability." The check points in process control assimilated in the development stage are strictly and closely followed.

For example, control items, sampling methods, equipment to be used, and supervisors, as well as persons to be contacted if any problems occur, are established for each process so that any abnormalities can be detected at an earlier stage, necessary actions can be taken promptly, and required data can be fed back correctly.

It is quite important to control the quality of component parts and materials. By standardizing individual specifications and quality control procedures, stringent quality control results.

Since semiconductor products and devices have made surprising progress over recent years, they have contributed to laborsaving, automation, and an improvement in quality and reliability. The facilities and instruments for quality control processes constitute important factors in quality control. Therefore, these factors are regularly controlled and calibrated in accordance with Toshiba's standards as well as national agencies.

In addition, the ZD (Zero defects) movement, small-group activities such as QC circles, and training and education programs as conducted to improve employees' workmanship and morale.

Fig. 1 Quality Assurance Process

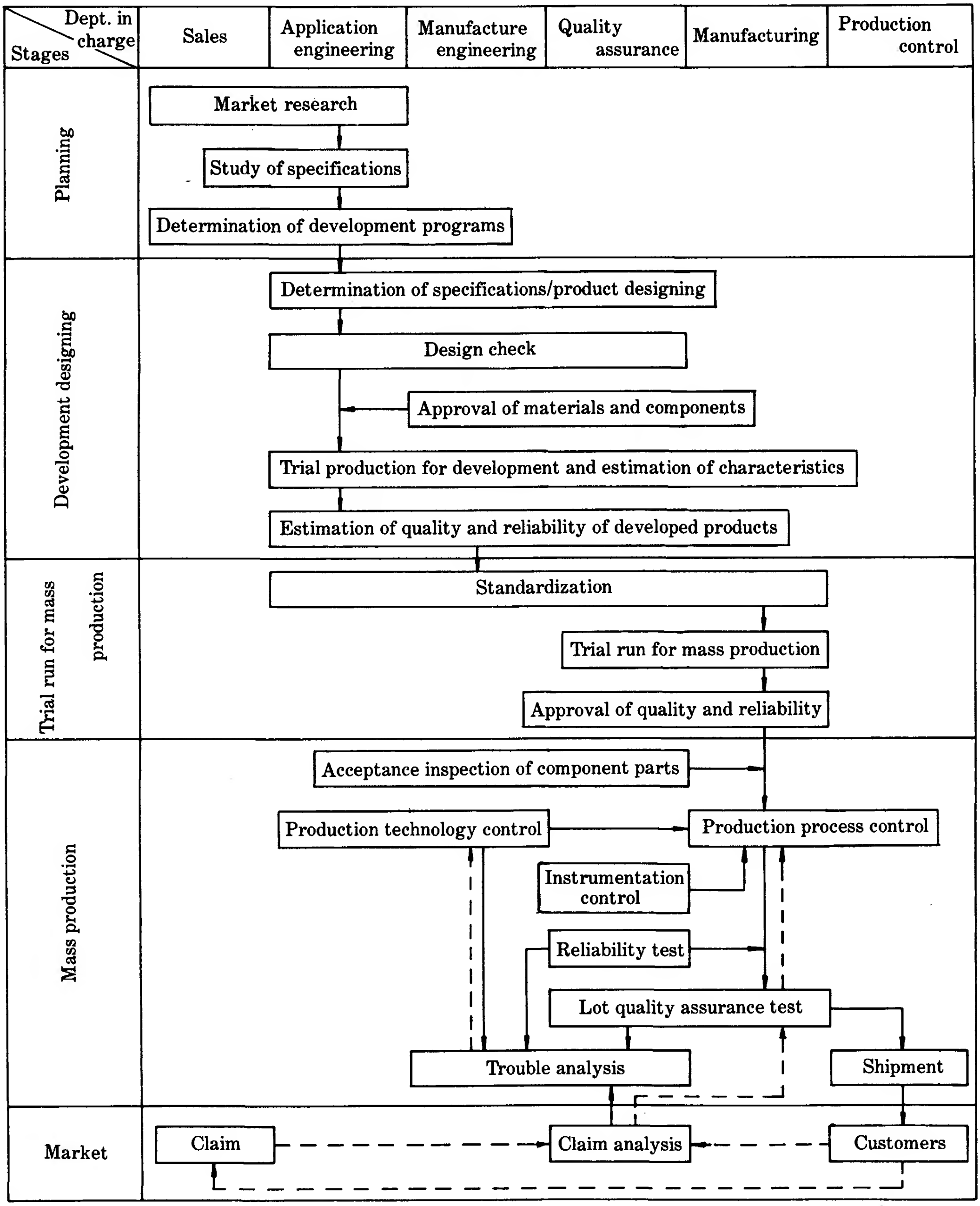

Dept. in charge
Stages
Sales
Application engineering
Manufacture engineering
Quality assurance
Manufacturing
Production control
Planning
Market research
Study of specifications
Determination of development programs
Development designing
Determination of specifications/product designing
Design check
Approval of materials and components
Trial production for development and estimation of characteristics
Estimation of quality and reliability of developed products
Trial run for mass production
Standardization
Trial run for mass production
Approval of quality and reliability
Mass production
Acceptance inspection of component parts
Production technology control
Production process control
Instrumentation control
Reliability test
Lot quality assurance test
Trouble analysis
Shipment
Market
Claim
Claim analysis
Customers

Table 1 Control system for product development

Development steps		Approval Test System (ATS)	Departments participating
Research and designing	Research, study, and establishment of quality and reliability goals so that products to be developed fulfill the expected functions	Design check	Development designing, application engineering, and quality assurance depts.
Trial run for development	Establishing production processes by duly considering economic merits and mass production capability, and by establishing quality and reliability	Estimation and approval of designs, DAT (Design Approval Test)	Application engineering, manufacturing engineering, fabrication group, and quality assurance depts.
Trial run for mass production	Establishing quality and reliability levels and process stabilizing/quality controlling methods	Estimation and approval of quality and reliability levels QAT (Quality Approval Test)	Production technology, quality assurance, production, and production control depts.
Mass production	Establishment of all controlling systems to manufacture standard products	DAT or QAT is conducted in accordance with the importance of any changes in components, materials, processes, and so on.	Production technology, quality assurance, production, and production control depts

(3) Quality assurance of delivered goods

The quality of products to be delivered is assured under the above-mentioned quality control, such as intermediate inspections and tests at each stage of processing and lot quality assurance tests (electrical properties, external appearance, structure, and service life).

Reliability check tests are regularly conducted to supervise quality and reliability levels. Results and data obtained from these inspections and tests are effectively utilized and filed for improving designing and production processes, as well as for estimating quality in the market.

The above-mentioned flow of products is shown in Fig. 2 quality assurance and confirmation flow chart.

The quality assurance criteria of Toshiba Corporation are based on the LTPD method which is in accordance with MIL-S-1900.

Quality assurance levels of the criteria are as listed in Table 2.

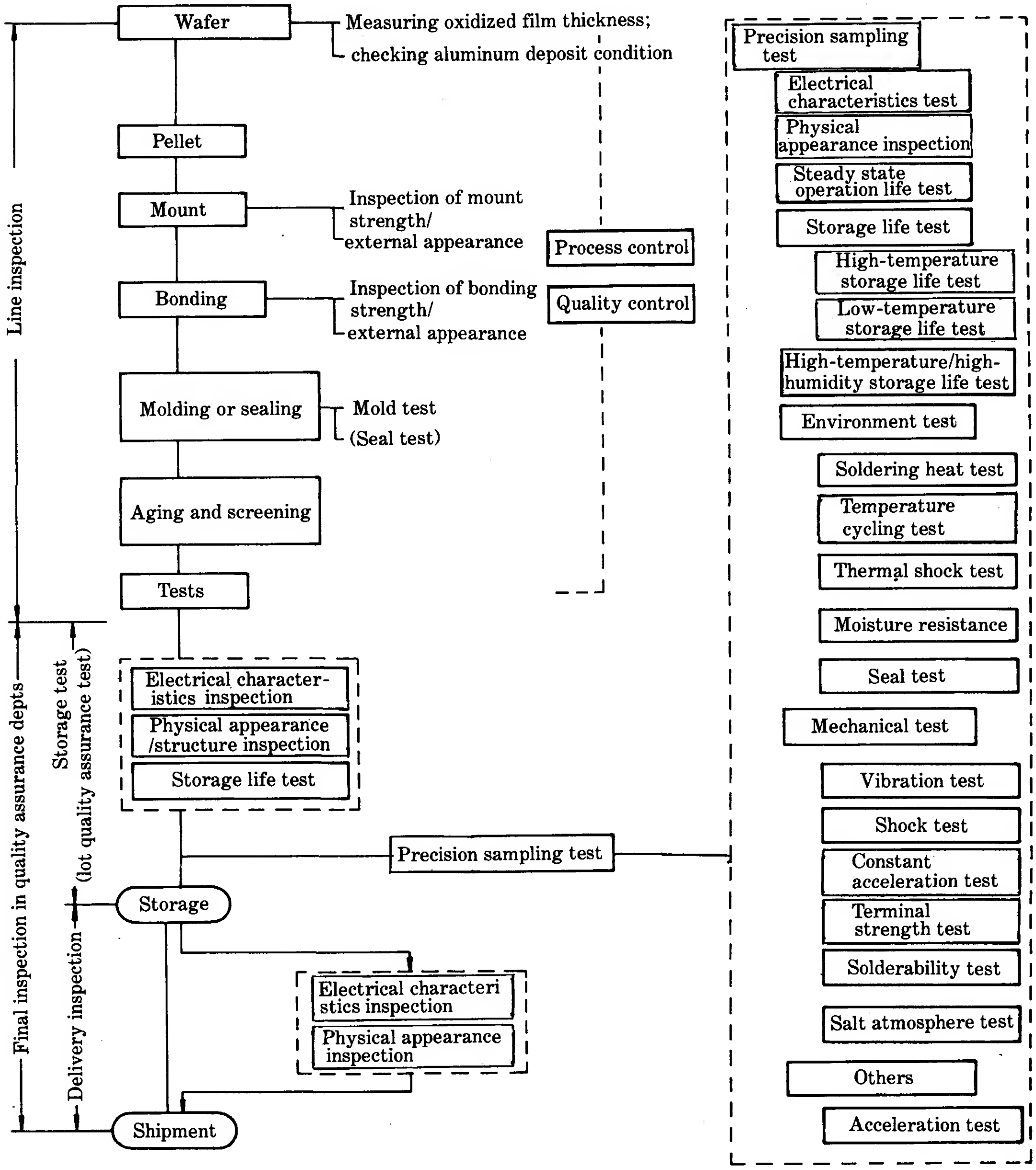
Table 2 Lot quality assurance level (LTPD method)

	Quality	Communications industry use	Household use
External appearance/structure/electrical properties	Catastrophic defects	1.5%	5%
	Major defects	5%	10%
	Minor defects	10%	25%

(4) Service activities after shipment

Market information related to quality and

Fig. 2 Quality assurance and confirmation flow chart



Wafer
Measuring oxidized film thickness;
checking aluminum deposit condition
Pellet
Mount
Inspection of mount strength/ external appearance
Bonding
Inspection of bonding strength/ external appearance
Molding or sealing
Mold test
(Seal test)
Aging and screening
Tests
Process control
Quality control
Line inspection
Final inspection in quality assurance depts
Storage test (lot quality assurance test)
Delivery inspection
Electrical characteristics inspection
Physical appearance /structure inspection
Storage life test
Precision sampling test
Storage
Electrical characteristics inspection
Physical appearance inspection
Shipment
Precision sampling test
Electrical characteristics test
Physical appearance inspection
Steady state operation life test
Storage life test
High-temperature storage life test
Low-temperature storage life test
High-temperature/high-humidity storage life test
Environment test
Soldering heat test
Temperature cycling test
Thermal shock test
Moisture resistance
Seal test
Mechanical test
Vibration test
Shock test
Constant acceleration test
Terminal strength test
Solderability test
Salt atmosphere test
Others
Acceleration test

reliability of products already shipped is very important for quality control purposes as well as for sales activities. Especially, any information in which the history and conditions of trouble occurrence are clarified is effective as a direct guideline for improving the quality and reliability of such products.

A variety of information obtained through contacts with customers is processed and computed to serve for studying the causes of trouble and for determining preventive measures, thus contributing to quality improvement.

2. Concept and scale of reliability

The quality that makes an element highly reliable is, that when it is used as a part of equipment, it "offers objective functions under stable conditions without failure for a specified duration of time", such an element should be easily compatible in electrical properties when replaced if necessary.

To quantitatively represent reliability, the degree of reliability or the ratio of failure is used to express it as a function of distribution in which time is used as one of the parameters. Therefore, the exponential distribution or the Wieble distribution is often used for semiconductor products.

Fig. 3 illustrates failures observed in ordinary electronic parts and semiconductors with time as a parameter; it has been recognized that this curve shows a certain trend.

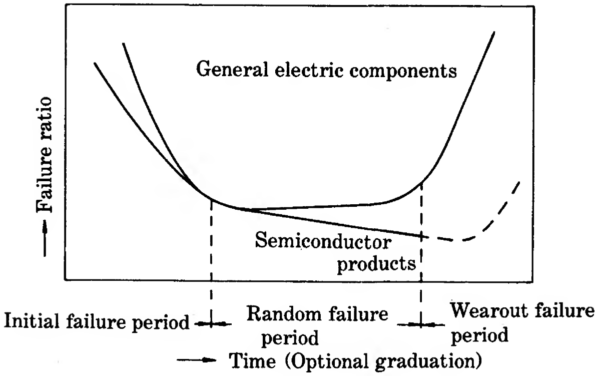


Fig. 3 Variation of failure rate regarding elapsed time

This trend is divided into three periods:

- Initial
- Random failure period
- Wearout failure period

Failure of semiconductor products is characteristic of a gradual reduction in the failure ratio during the random failure period; it is important to minimize the failure ratio in this period because failure occurs at random.

To represent the reliability of semiconductor products, an approximation is conducted by using various types of distribution functions. When assuming an exponential distribution, the most basic distribution pattern in life distribution of electronic components, the reliability function $R(t)$ can be expressed by the equation—

$R(t)=\exp(-\lambda t)$

The instantaneous failure ratio $\lambda(t)$ and average life μ are expressed as—

$\lambda(t)=\lambda$ (constant irrespective of time lapse)

$\mu=1/\lambda$

$\mu=1/\mu=\text{MTTF}$.

Generally, the failure ratio of semiconductor products is expressed by %/1,000 hours through assuming that time (t)=1,000 hours. Since failure is rare and the failure ratio is small judging from the field data and estimated failure ratio, $1/10^4$ times this value—namely 10^{-4} (%/1,000 hours)$=10^{-9}$ (failures/hour)—is used under the unit of 1 Fit.

3. Reliability factors

The reliability of transistors should be handled not only for the transistors themselves, but by also taking operational stress and environmental stress into consideration. They are so closely related to each other that the following explanation will help users to utilize them with higher reliability.

(1) Operating conditions

Voltage and current supplied to transistors and the operating conditions surrounding equipment are important factors which affect transistor reliability. The operating points should be determined by selecting and appropriate element for an objective circuit and by designing an appropriate circuit.

It is known that the transistor failure ratio is substantially affected by temperature, and as the temperature rises, the ratio is increased. However, small-signal transistors handle such low voltage and current that no special consideration need be given to temperature, except for those circuits with special operation.

Instead of considering the influence of temperature, attention should be paid to the application of surge voltage and deviation in characteristcs caused by external influences or induction. By lowering the limit values for allowable fluctuations in characteristics, to widen the difference between theoretical and actual operation limits when designing a circuit, it is possible to substantially increase the service life of a transistor, and hence, that of the equipment. On the other hand, power transistors which handle comparatively large voltage and current have large dissipations as a result of a far larger volume of current compared with voltage.

This power dissipation causes a transistor to heat up, adversely affecting both its characteristics and its reliability. Such heat should be efficiently discharged. Refer to the explanation in the previous section for details of heat discharge.

It is recommended that derating be applied to the voltage, current, and temperature specified by maximum ratings, so that transistors may be employed with high reliability. Since derating is determined as a compromise between reliability and economic values, it is rather difficult to consistently specify the degree of derating. The degrees mentioned below are those generally recommended:

Voltage: 70—80% or less for maximum rating
Current: 50% or less for maximum rating
Power: 50% or less for maximum rating

Regarding the degrees of derating, certain government agencies in Japan have established their own standards for operation and designing, and have limited the application ranges. Such a movement constitutes one of the basic activities for improving transistor reliability.

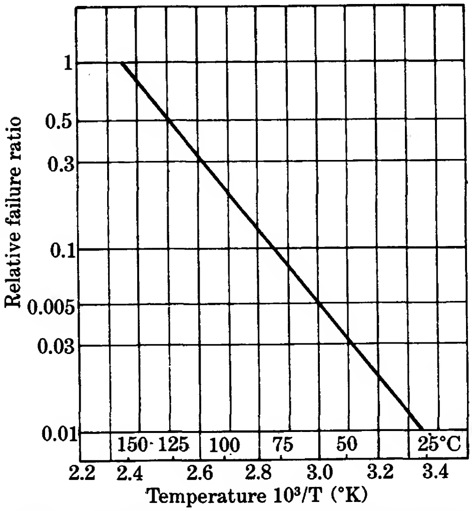


Fig. 4 Derating curve for silicon transistors

Fig. 4 shows an example of relations between the temperature and the failure ratio by using a Toshiba silicon transistor. It is evident from that figure that the failure ratio is substantially affected by the operating temperature and that higher reliability can be expected by effecting derating.

(2) Variations in transistor quality

The automatization of production processes and the improvement and progress of production technology have been outstanding. The quality and reliability of transistors have continued to be improved year after year thanks to such development, and by positively adopting newly developed technology.

It has probably been stated that there are no variations in quality thanks to the use of modern controlling methods and the full automation of processes. However, transistors and other semiconductor products are extremely small in shape, structure, and size, and are based on microtechnology for conducting their high-precision control, reinforced by physical and chemical technology. Therefore, even the slightest deviation exercises a large influence upon a transistor's characteristics. It is rather difficult to maintain various types of characteristics uniform, even by making full use of today's latest technology.

(3) Resistance against environmental factors

The housings of semiconductor products are classified into the plastic resin-sealed type and the airtight-sealed type using metal. The plastic resin-sealed type, less expensive and possible to mass produce, recently has been employed in the majority of cases, covering application ranges from small signal to large power transistors.

This trend is backed by the facts that resins with high mechanical strength and excellent electrical insulation and resistance against environmental factors have been developed and employed, and that the reliability of this type has been greatly enhanced thanks to progress in molding techniques and surface treatment know-how.

The plastic resin-sealed type up to now has reached the level of the airtight-sealed type except concerning special environments, although transistors are subjected to many environments in the markets. Since the plastic resin-sealed type is not airtight, humidity infiltrates the transistor interior through the resin. It is recommended employing the airtight-sealed type if the equipment or system is intended for use under a high-humidity environment or when high reliability is required.

Be careful not to directly expose semiconductor products to dust, harmful gases, salty (sea) air, radioactive rays, or similar environments; otherwise, they will suffer from unstable characteirstics or rust in the lead wires.

4. Precautions of handling

(1) Mounting on printed circuit boards

When mounting a transistor on a printed circuit, it is assumed that lead wires will be processed or reformed due to space limitation or relations with other components. Even if no such special processing or reforming is conducted, exercise care on the following points:

(a) Make the spaces of lead wire inserting holes on the printed circuit board the same as those of lead wires on a transistor.

(b) Even if the spaces are not the same, do not pull the lead wires or push heavily against the transistor element.

For TO-220AB-type transistors, do not apply stress in the direction of the lead wire thicker side.

(c) Use a spacer for form a lead maintain space between a transistor and a printed circuit board, rather than closely contacting them with each other.

(d) When forming a lead prior to mounting onto a board:

- Bend the lead at a point 3 mm or more apart from the body. (Lead root)
- Bend one lead wire after securing the other lead wire (near the main body).
- Keep space between the transistor main body and a fixing jig.
- When bending the lead along the jig, be careful not to damage it with an adge of the jig.
- Follow other precautions described in respective standards.

(e) When mounting a transistor onto a heat sink:

- Use the specified accessory.
- Drill threaded holes on the heat sink as per specifications and keep the surface free drom burrs and undulations.
- Use Toshiba's recommended silicon grease.
- Tighten the screws within the specified torque.
- Never apply a pneumatic screwdriver to a transistor main body.

(f) Do not bend or stretch the lead wires repeatedly.

When pulling in the axial direction, apply 500g or 1 kg power, depending on the shapes of lead wires.

(2) Soldering

When soldering a transistor to a printed circuit board, the soldering temperature is usually so high that it adversely affects the transistor. Normally, tests are conducted at a soldering temperature of 260°C for 10 seconds or 350°C for 3 seconds. Be sure to complete soldering procedures under these conditions of temperature and time.

Be careful to select a type of flux that will neither corrode the lead wires nor affect the electrical characteristics of a transistor.

The basic precautions for soldering procedures are as follows:

(a) Complete soldering procedures in a time as short as possible.

(b) Do not apply stress to a transistor after soldering by correcting or modifying its location or direction.

(c) For a transistor employing a heat sink, mount it on the heat sink first; then solder this unit to a printed circuit board after confirming that it is fully secured.

(d) Do not directly solder the heat-radiating portion of a transistor to a printed circuit board.

(e) In flow solder jobs, transistors are apt to float on the solder due to solder surface tension. When adjusting the locations of transistors, be careful not to apply excessive stress to the roots of the transistor lead wires.

(f) When using a soldering iron, select those which have less leakage, and be sure to ground the soldering iron.

(3) Cleaning a circuit board

After soldering, circuit boards must be cleaned to remove flux. Observe the following precautions while cleaning them.

(a) The below-mentioned solvents are recommended for cleaning purposes:

- Freon TE, TF
- Di-Freon Solvent S3-E

(b) Do not rub the indication marks with a brush or one's fingers when cleaning or while a cleaning agent is applied to the markings.

(c) There areultrasonic wave cleaning methods which offer a high cleaning effect within a short time. Since these methods involve a complicated combination of factors such as the cleaning bath size, ultrasonic wave vibrator output, and printed circuit board mounting method, there is fear that the service life of airtight seal-type transistors may be extremely shortened. Therefore, as far as possible avoid using the ultrasonic wave cleaning method. This concern is not applicable to plastic-type transistors, although below-mentioned basic requirements should be followed:

- Basic requirements of ultrasonic wave cleaning method

Frequency:	27—29 kHz
Output:	300W or less (about $0.3W/cm^2$ or less)
Recommended solvents:	Refer to details above
Cleaning time:	30 seconds or less

Conduct ultrasonic wave cleaning with both the printed circuit board and the transistors floating in the solvent, so that neither product comes in direct contact with the ultrasonic wave vibrator.

It is recommended adopting steam cleaning or jet stream cleaning methods which exert less influence on transistors than dose ultrasonic wave cleaning; it is assummed that various types of transistors are mounted on a printed circuit board.

(4) Static electricity

The maximum ratings designated for transistors denote those values which should not be exceeded even an instant, as described in the previous section; this is applicable commonly to semiconductor products.

It is probable, however, that static electricity or surge voltage that exceed such values may be applied to transistors directly or indirectly while handling or operating them.

Especially, static electricity sometimes reaches several kV or tens of kV. Should this high voltage be discharged through the electrodes of transistors, high-frequency transistors and MOS-FET transistors which are less resistive to such high voltage in structure, they may be deteriorated or break down. Since protective devices to be mounted on the transistors themselves are restricted for the purpose of assuring electrical characteristics, pay special attention to handling procedures and to separate protective circuits.

Such wires as I/O signal wires and control wires connected to a printed circuit are often connected with other types of electronic components, and they are often very long. Should noise or surge voltage caused by induction be added to these I/O signal wires and control wires, transistors may sometime deteriorate or break down. Take advance protective measures such as inserting protective circuits.

5. Failure mode and failure mechanism

Types of failure are classified into open circuits, short circuits, and deterioration.

(1) Open failure

Factors causing open failure are

(a) Structural flaws related to or caused by bonding

(b) Those caused by electrochemical reaction such as electromigration and local cell formation

(c) Application of stress exceeding that guaranteed by the standards

It is also possible that bonding wires and aluminum wires may be fused off as a result of a combination of the above three factors.

(2) Short failure

Principal factors causing short are

(a) Excessive stress caused by overvoltage and overcurrent

(b) Short failure caused by an extreme example of degradation

(c) Electrochemical reaction

(3) Degradation

From the viewpoint of electrical characteristics, degradation denotes a reduction of withstand voltage lower than the specified value, an abnormal increase in current, and a drift of characteristic values.

Since transistors are produced based on

physical and chemical technology, it is assumed that thermodynamic changes on the surface or in the interior of a transistor caused by voltage, current, temperature, or humidity will result in changes in its physical and chemical properties. As such changes increase gradually, the specified values will be finally exceeded.

The principal factors for deterioration are supposedly—

(a) Structural flaws
(b) Designing problems
(c) Operating problems

Table 3 Lists the relations between failure modes caused by these factors and failure mechanisms.

Table 3 Relationship between failure modes and failure mechanisms

Failure mode	Failure factors \ Failure mechanisms	Structural items				Seal		Interior					Surge		
		Structural flaws	Contact and connecting portions	Correlation between components	Thermal fatigue	Defective housing	Sealing	Junction imperfection	Surface channel	Entrapped foreign gas ions	Ionic conduction	Corrosion	Overcurrent	Overvoltage	Static electricity
Open circuit	Open lead (fused)												○		
	Open lead (mechanical)	○			○										
	Abnormal bonding.	○	○	○	○							○			
Short circuit	Junction short circuit				○			○					○	○	○
	Arcing													○	○
	Pellet crack	○		○	○										
	Infiltrated foreign matter	○				○									
	Contact between leads	○	○	○		○									
Degradation	Atmosphere						○		○	○	○	○			
	Smears				○				○	○	○	○			
	Influence of surface oxidized film				○				○		○	○			
	Junction interior				○			○							○
	Arcing													○	○
	Pellet cracks	○		○	○										
Others	Defective external lead wires	○	○			○									
	Housing surface leak	○				○									
	Rust					○									

6. Reliability test

Reliability tests are conducted either for maintaining and confirming reliability assurance levels or for comprehending the design margins and limit levels for using such data when renewing a design.

The reliability test methods and conditions differ according to respective objectives. Normally, an accelerated life test and an environment test are conducted based on maximum ratings by simulating stresses to which transistors will be subjected in actual operation.

Since some tests posses destructive characteristics, it is important to establish reproducible, generally applicable test methods and conditions.

Standard test methods applicable to semiconductor products include JIS, EIAJ, MIL, and IEC standards. Some typical standards among them are described hereunder; the contents of reliability tests are listed in Table 3.

- Japanese Industrial Standards (JIS)

JIS C5003	General test procedure of failure ratio for electronic components
JIS C5700	General rules for reliability assured electronic components
JIS C7021	Environmental testing methods and endurance testing methods for discrete semiconductor devices
JIS C7030	Testing methods for transistors
JIS C7032	General rules for transistors
JIS C7210	General rules for reliability assured discrete semiconductor devices

- Electronic Industries Association of Japan (EIAJ) Standards

EIAJ SD-121	Environmental and mechanical test methods for discrete semiconductor devices
EIAJ SD-71	Transistor test methods
EIAJ SD-31	Field-effect transistor test methods

- U.S. Military Standards (MIL)

MIL-STD-202	Test methods for electronic and electrical components parts
MIL-STD-750	Test methods for semiconductor devices
MIL-S-19500	Semiconductor devices, general specifications for

Table 4 Types and Contents of Reliability Tests

Clasifi-cation	Types	Description	Applicable standards
Initial performance test	Initial characteristics test	Items of electrical characteristics specified as ratings by respective standards are tested to confirm they fall within requirements of the standards.	
	Appearance, dimensions, and structure tests	Tests are conducted to confirm that materials, polarity, structure, external shapes, dimensions, marking, and external appearance of a transistor are in normal condition or within the allowable limits specified.	
Operation life test	Steady state operation life test:	Durability of a transistor is judged by applying electrical stress (voltage and current) and thermal stress (including temperature rise caused by load) to that transistor over a long period. This test is normally conducted by continuously applying voltage, current, or power at 25±5°C.	EIAJ SD-121 B-4 JIS C7021 B-4 MIL-STD-750B: 1026
	Intermittent operation life test:	Electrical and mechanical durability of a transistor is judged by intermittently feeding power to that transistor and by raising/lowering temperature in accordance with ON/OFF conditions. This test is normally conducted at 25±5°C under separately specified electrical and time conditions (such as power feeding cycle and interrupting cycle.)	EIAJ SD-121 B-6 JIS C7021 B-6 MIL-STD-750B: 1036
Storage life test	High-temperature storage life test:	Durability of a transistor is judged by storing the transistor at high temperature. Normally, the test temperature is the maximum rated storage temperature (Tstg Max).	EIAJ SD-121 B-9 JIS C7021 B-10 MIL-STD-750B: 1031
	Low-temperature storage life test:	Durability of a transistor is judged by storing the transistor at low temperature. Normally, the test temperature is the minimum rated storage temperature (Tstg Min).	EIAJ SD-121 B-9 JIS C7021 B-12
	High-temperature/high-humidity storage life test:	Durability of a transistor is judged under operation and storage at high relative humidity over a long period. Normally, the test conditions are 60°C and 90%RH.	EIAJ SD-121 B-10 JIS C7021 B-11 MIL-STD-202E: 103B

Clasifi-cation	Types	Description	Applicable standards
Environment test	Soldering heat test:	Heat resistance of a transistor is determined against heat to which it is subjected while soldering. Normally, the test conditions are 206±5°C for 10 seconds.	EIAJ SD-121 A-1 JIS C7021 A-1 MIL-STD-750B: 2031
	Temperature cycling test:	Thermal resistance of a transistor is determined by exposing it to high and low temperatures. Normally, the test is conducted for 5 cycles of minimum and maximum storage temperatures.	EIAJ SD-121 A-4 JIS C7021 A-4 MIL-STD-750B:.1051
	Moisture resistance test (temperature/humidity cycling test):	Durability of a transistor is determined by exposing it to high humidity under low and high temperature cycles. Normally, the test conditions are Ta=25°C — 65°C to −10°C and RH=90 — 98%. The test is conducted for ten cycles, with one cycle continued for 24 hours.	EIAJ SD-121 A-5 JIS C7021 A-5 MIL-STD-750B: 1021
	Seal test:	Air tightness of the seal is determined. Tiny gas leakages are detected by using tracer gas, large leakages by air bubbles.	EIAJ SD-121 A-6 JIS C7021 A-6 MIL-STD-750B: 1071
Mechanical test	Solderability test:	Ease in soldering lead wires is determined. Normally, the test is conducted at 230±5°C for 5 seconds.	EIAJ SD-121 A-2 JIS C7021 A-2 MIL-STD-750B: 2026
	Vibration test:	Durability against vibration during transportation or operation is determined. Normally, changes in vibration frequency (100 −2000 Hz) are applied.	EIAJ SD-121 A-10 JIS C7021 A-10 MIL-STD-202E: 2046, 2056
	Shock test:	Structural and mechanical durability is judged. The test is conducted by applying 1500G three times each in four directions.	EIAJ SD-121 A-7 JIS C7021 A-7 MIL-STD-750B: 2016
	Constant acceleration test:	Durability against constant acceleration is determined. The test is normally conducted by applying 20,000G for 1 min. in six directions.	EIAJ SD-121 A-9 JIS C7021 A-9 MIL-STD-750B: 2006

Clasifi-cation	Types	Description	Applicable standards
Mechanical test	Drop test:	Structural and mechanical durability is judged. Normally, a test piece is dropped three times from the height of 75cm onto a maple board.	EIAJ SD-121 A-8 JIS C7021 A-8
	Lead strength test:	Lead strength is determined as to whether or not leads are strong enough to endure force to be applied while mounting, wiring, or operating. Normally, lead wires are bent three times by 90° through applying a 250g weight.	EIAJ SD-121 A-8 JIS C7021 A-8 MIL-STD-750B: 2036
	Salt atmosphere test:	Corrosion resistance of a transistor is determined. Normally, the test is conducted at 35°C room temperature by spraying with 5% salt solution for 24 hours. The test is conducted for ten cycles, with one cycle continued for 24 hours.	EIAJ SD-121 A-2 JIS C7021 A-2 MIL-STD-750B: 1046
Acceleration test	Acceleration test:	Generally, life tests consume a long time; at present, especially, the time when the reliability of transistors has been enhanced substantially, life tests require an extremely long time and many samples. Therefore, a forced deterioration test is conducted by increasing stresses exceeding the rated values. The types of forced deterioration factors which should be used such a this test differ substantially depending on the mechanism to cause failures. It is important, therefore, to select forced deterioration factors suitable for the mechanism to be inspected. Additionally, it is necessary to fully comprehend the relations with normal life tests.	

7. Reliability data

Tables 5 and 7 display the results of reliability tests as a typical example of tests conducted in accordance with the above-mentioned test methods, by using a plastic resin sealed-type, small-signal transistor.

Typical criteria for judging failures in these tests are listed in Tables 6 and 8.

Variations by time of various characteristic parameters in operation tests are often analyzed in detail as one of the most basic procedures for estimating transistor reliability. Variations by time of such parameters in life tests conducted as to Tables 5 and 7 are shown in Figs. 5 and 6 as typical examples.

It is evident from these data that initial characteristics are maintained over long hours despite the fact that these tests were conducted based on test conditions using maximum ratings.

It is presumed, therefore, that high reliability can be expected under actual operating conditions of equipment or a device.

Table 5 Results of reliability tests using plastic resin sealed-type small-signal transistor 2SC1815

	Test item	Applicable standards (JIS C7021)	Test conditions	Sample size	Failures	Remarks*
Life test	Steady state operation	B—4	Vc=25V, Pc=300mW Ta=25°C, 1000Hrs	230	0	0.4
	High-temperature storage	B—10	Ta=125°C, 1000Hrs	210	0	
	High-temperature/ High-humidity storage	B—11	Ta=60°C, RH=90% 1000Hrs	230	0	
Environmental test	Soldering heat	A-1	260°C, 10 sec., 1 time (up to 1.5mm from lead root)	170	0	
	Temperature heat	A-4	−55°C~25°C~125°C~25°C 20 cycles	530	0	
	Thermal shock	A-3	100°C~0°C, 10 cycles	190	0	
	Moisture resistance	A-5	Ta=~65°C, RH=90~98% 10 cycles	190	0	
Mechanical tests	Vibration	A-10	100~2000Hz 20G 3 directions x four times each	60	0	
	Shock	A-7	1500G, 0.5ms 4 directions x 3 times each	60	0	
	Constant acceleration	A-9	20000G, 6 directions x 1 min.	60	0	
	Lead strength	A-11	250g, 90° bending x 3 times	90	0	
	Drop	A-8	75cm, maple board	90	0	
	Solderability	A-2	230°C, 5 seconds (using specified flux)	90	0	

*Failure ratio = %/1,000 hrs, 60% confidence level

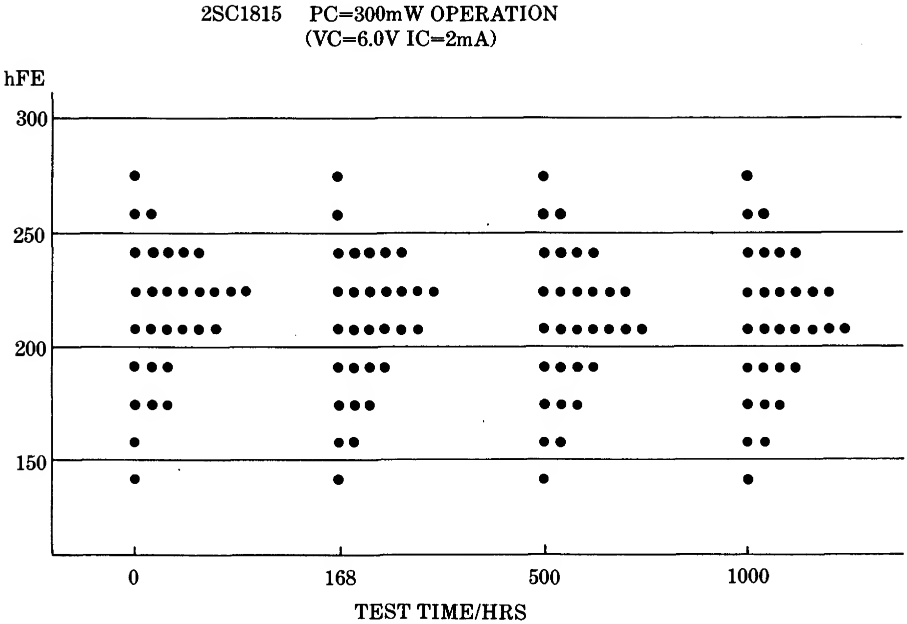


Fig. 5 **Typical example of results of steady state operation life test of plastic resin sealed-type 2SC1815**

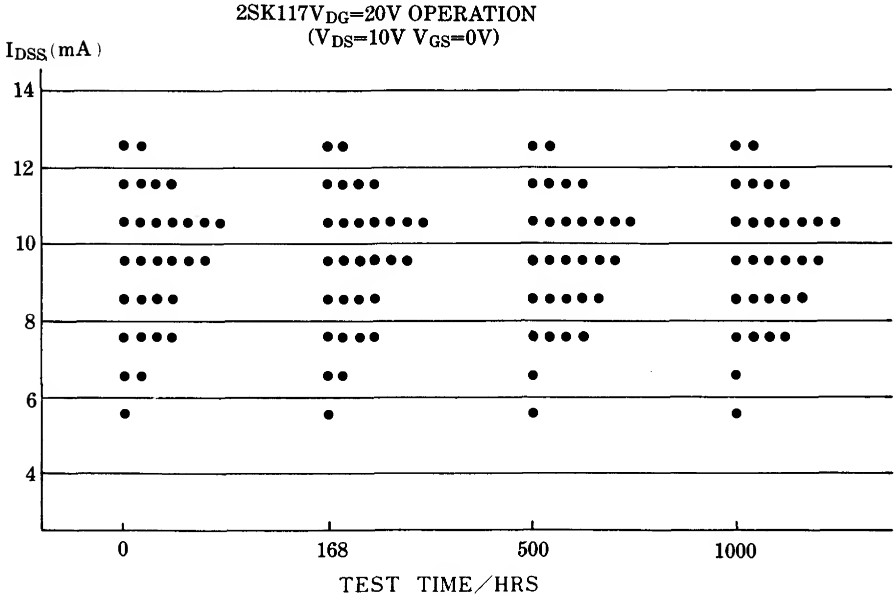


Fig. 6 **Typical example of results of steady state operation life test of plastic resin sealed-type 2SK117**

Table 6 Criteria on failures for 2SC1815

Items of characteristics	Symbols	Measuring conditions (Ta=25°C)	Criteria*	Remarks
Collector cutoff current	I_{CBO}	V_{CB}=60Vm I_E=0	USLx2	0.2μA Max
Emitter cutoff current	I_{EBO}	V_{EB}=5V, I_C=0	USLx2	0.2μA Max
Static forward current transfer ratio	h_{FE}	V_{CE}=6V, I_C=2mA	USLx1.2 LSLx0.8	56~480

*USL: Upper specification limit, LSL: Lower specification limit

Table 7 Extracted results of reliability tests using plastic resin sealed-type FET transistor 2SK117

	Test item	Applicable standards (JIS C7021)	Test conditions	Sample size	failures	Remarks*
Life test	Steady state operation	B−5	V_{DS}=20V Ta=25°C, 1000Hrs	190	0	0.5
	High-temperature storage	B−10	Ta=125°C, 1000Hrs	190	0	
	High-temperature/ High-humidity storage	B−11	Ta=60°C, RH=90% 1000Hrs	190	0	

*Failure ratio = %/1,000 hrs, 60% confidence level

Table 8 Criteria on failures for 2SK117

Items of characteristics	Symbols	Measuring conditions (Ta=25°C)	Criteria*	Remarks
Gate leak current	I_{GSS}	V_{GS}=−30V, V_{DS}=0	USLx2	−2.0nA Max
Gate drain voltage with source short-circuited to drain	V_{GDS}	V_{DS}=0, I_G=~100μA	LSLx0.9	−45V Min
Drain current	I_{DSS}	V_{DS}=10V, V_{GS}=0	USLx1.2 LSLx0.8	0.48~16.8mA

*USL: Upper specification limit, LSL: Lower specification limit

Characteristics of Transistor

Equivalent parameters of a transistor include the device parameters which closely respond to the internal operating mechanism of a transistor and the circuit parameters which are indicated as a matrix obtained from regarding a transistor as a terminal circuit network.

These parameters are also divided into small-signal equivalent circuits (analog circuits) and large-signal equivalent circuits (digital circuits), in accordance with the extent of signals (amplitude) to be handled.

Equivalent circuits have been developed very much. It is necessary for circuit designers to select an optimal one by paying attention to the application ranges and operating limits of respective equivalent circuits. Table 1 lists equivalent circuits presently employed. Among others, small-signal eqivalent circuits are hereafter described, since they are generally used.

Table 1 List of transistor equivalent circuits

- Transistor equivalent circuits
  - Small-signal equivalent circuits (general linear circuits such as amplification, oscillation, modulation, and demodulation)
    - Device parameters
      - Early's T-type equivalent circuits (common base circuit)
      - Giacoletto's π-type equivalent circuit (emitter and collector common circuit)
    - Circuits parameters
      - Matrices showing the relation among the input and the output by voltage and current
        - a,b matrices;
        - g,h matrices (low frequency);
        - y,z matrices (high frequency)
      - Matrix showing the relation among the input and the output by power
        - s matrices
        - (superhigh frequency)
        - (transmittance coefficient, reflection coefficient indication)
  - Large-signal equivalent circuit—device parameter (nonlinear circuit such as pulse, digital, and switching circuits)
    - Current control model by Evers-Moll;
    - Charge control model by Beaufoy-Sparkes;
    - Density control model by Linvill;
    - other nonlinear models

1. Device parameter

(1) Early's T-type equivalent circuit

(Bipolar transistor)

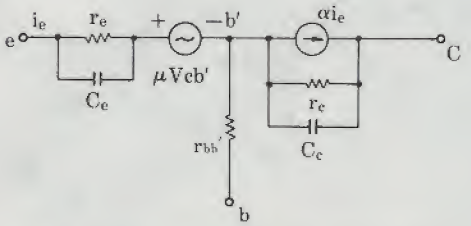


Fig. 1 Early's T-type equivalent circuit

Figure 1 shows Early's T-type equivalent circuit.

r_e: Emitter resistance,

This is represented by the following equation, since it is forward-biased resistance with emitter-to-base junction:

$$r_e = \frac{kT}{qI_E}(\Omega) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

where,

k: Boltzman's constant (1.38×10^{-26}J/°K)

T: Absolute temperature (°K)

q: Electric charge of electron (1.60×10^{-19}C)

I_E: Emitter current (A)

Equation (1) is changed as follows at normal temperature (300°K) if the emitter current is represented by mA:

$$r_e = \frac{26}{I_E\,(mA)}(\Omega) \cdots\cdots\cdots\cdots\cdots\cdots \quad (2)$$

C_e: Emitter capacitance $(C_{Te}+C_{De})$

This is represented as a sum of the depletion layer capacitance and the diffusion capacitance. Normally since the depletion layer capacitance in an emitter-to-base junction is far smaller than the diffusion capacitance, it can be ignored.

The depletion layer capacitance C_{Te} and the diffusion capacitance C_{De} are represented as—

$$C_{Te}=A_e\sqrt{\frac{\frac{1}{2}\varepsilon q n_N}{\phi_0-V_{b'e}}}\,(F) \cdots\cdots\cdots\cdots\cdots \quad (3)$$

where,

Ae: Emitter junction area (m^2)

ϵ: permittivity

n_N: Majority carrier density (m^{-3}) on high specific resistance side (NPN in this case)

ϕ_0: Contact potential difference (potential fault when balanced) (V)

$V_{b'e}$: Potential applied to both ends of base to emitter junction (1)

$$C_{De} = \frac{qI_E W^2}{2kTD}(F) \cdots\cdots\cdots\cdots\cdots\cdots \quad (4)$$

where,

W: Base width (m)

D: Diffusion coefficient of minority carrier in base area (m^2/sec)

μ: Voltage feedback ratio (Early constant)

This constant, known as the Early effect, is a base width modulation parameter,

$$\mu = \frac{kTd_c}{3qW(\phi_0-V_{b'c})} \cdots\cdots\cdots\cdots\cdots \quad (5)$$

where,

d_c: Width of collector depletion layer (m)

r_c: Collector resistance

This is a kind of base width modulation parameter, represented as follows:

$$r_c = \frac{1}{I_E\left(\frac{\partial\alpha}{\partial V_{b'c}}\right)}(\Omega) \cdots\cdots\cdots\cdots\cdots \quad (6)$$

The value of r_c is usually 1— 2 MΩ or so.

C_c: Collector capacitance

Similarly to emitter capacitance, this is shown as the sum of depletion layer capacitance and diffusion capacitance of the collector-to-base junction. However, since the diffusion capacitance of the collector-to-base junction is far smaller than the depletion layer capacitance, it can be ignored. The depletion layer capacitance is represented as

$$C_{Tc}=A_c{}^3\sqrt[3]{\frac{\frac{\varepsilon^2 qa}{12}}{\phi_0-V_{b'e}}}\,(F) \cdots\cdots\cdots\cdots \quad (7)$$

where,

A_c: Collector junction area (m^2)

a: Impurity concentration gradient (m^{-4})

$V_{b'c}$: Potential applied to both ends of base to collector junction (V)

Usually the value of Cc is 1—10pF.

α: DC forward current transfer ratio

This is the only parameter among Early's T-type parameters that depends on frequency, represented by the equation

$$\alpha = \frac{\alpha_0}{1+j\omega C_e r_e} \qquad f\alpha = \frac{1}{2\pi C_e r_e}$$

therefore,

$$\alpha = \frac{\alpha_0}{1+j\frac{f}{f\alpha}} \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (8)$$

where,

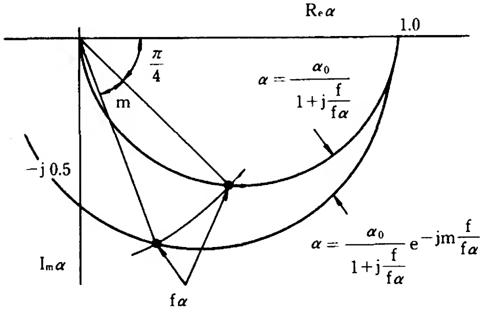
α_0: Value of α at low frequency

f_α: α-interrupting frequency (frequency at which α is reduced by 3db less than α_0)

Fig. 2 shows the frequency locus of α. When actually measuring α, the difference between theoretical and measured values is increased as the frequency approaches $f\alpha$. This is because Early's equivalent circuit is based on the primary approximation of physical phenomena.

To correct it, Thomas-Moll introduced excess phase m and offered the equation

$$\alpha = \frac{\alpha_0}{1+j\frac{f}{f\alpha}} e^{-jm\frac{f}{f\alpha}} \cdots\cdots\cdots\cdots \quad (9)$$



Reα
1.0
π/4
m
$\alpha = \frac{\alpha_0}{1+j\frac{f}{f\alpha}}$
−j 0.5
Imα
$\alpha = \frac{\alpha_0}{1+j\frac{f}{f\alpha}} e^{-jm\frac{f}{f\alpha}}$
fα

Fig. 2 Frequency locus of α

The above equation agrees well with measured values in frequencies less than f_α.

DC Current gain (β) at common emitter is represented as follows:

$$\beta = \frac{\alpha}{1-\alpha} = \frac{\alpha_0}{(1-\alpha_0)+j\frac{f}{f\alpha}}$$

The β-interrupting frequency f_β is defined as the frequency at which the absolute value of β becomes $\beta_0/\sqrt{2}$, similarly to $f\alpha$, f_β is represented as—

$$f_\beta = \frac{\alpha_0}{\beta_0} f\alpha$$

therefore,

$$\beta = \frac{\beta_0}{1+j\frac{f}{f_\beta}} \cdots\cdots\cdots\cdots \quad (10)$$

$r_{bb'}$: Base diffusion resistance

This is resistance from the center of base area to the external base terminal which actually contributes to transistor action and is determined according to shape and dimensions of the transistor and base specific resistance.

$$r_{bb'} \doteqdot \frac{q_B}{8\pi W} (\Omega) \cdots\cdots\cdots\cdots \quad (11)$$

where,

q_B: Specific resistance of base area (Ω·m)

(2) Giacoletto's π-type equivalent circuit (bipolar transistor)

Fig. 3 shows the π-type equivalent circuit. This equivalent circuit is in itself the same as Early's T-type equivalent circuit mentioned above. The only difference from Early's T-type eqivalent circuit is that each parameter has—in principle— no frequency response.

Since the physical meaning of each parameter is easy to understand, this circuit is popularly employed. When actually employed for circuit calculation, it will prove convenient if the basic style shown in Fig. 3 is slightly simplified by considering frequency range.

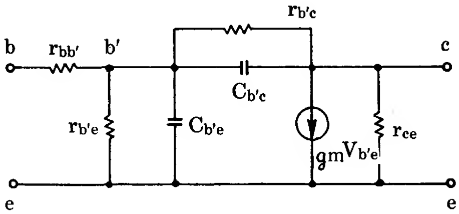


Fig. 3 π-type equivalent circuit

Paramaters of the T-type equivalent circuit and those of the π-type have the correlation shown in Table 2.

Table 2 Relationship between paramaters of T-type and π-type equivalent circuits

π-type equivalent circuit paramaters	T-type equivalent circuit paramaters
$C_{b'e}$	C_e
$r_{b'e}$	$\frac{r_e}{1-\alpha_0}$
$C_{b'c}$	C_c
$\frac{1}{r_{b'c}}$	$\frac{1}{r_c} - \frac{\mu(1-\alpha_0)}{r_e}$
r_{ce}	$\frac{r_e}{\mu}$
g_m	$\frac{\alpha_0}{r_e}$
$r_{bb'}$	$r_{bb'}$

(3) FET equivalent circuit

Similarly to bipolar transistors, FET can be indicated by using an equivalent circuit. Fig. 4 is a schematic diagram of the equivalent circuit by relating to its structure.

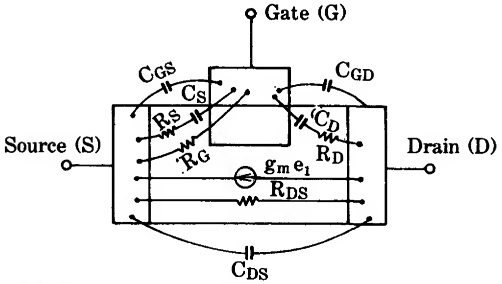


Fig. 4 equivalent circuit in relation to structure of an FET

This diagram is rewritten into an equivalent circuit in Fig. 5(a), and further rewritten into a practical, simplified equivalent circuit in Fig. 5(b).

C_{GD}, C_{GS} and C_{DS} shown here are parasitic capacitances. Since their values are relatively small, it is possible to ignore them unless this circuit is used in VHF regions.

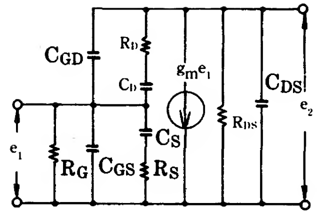
However, when using transistors whose capacitances between electrodes are large, such as a power FET and a high-gm FET in low-frequency regions, these capacitances must be considered fully.

For FET to be used in chopper circuits, it is necessary to keep the difference between C_{DG} and C_{GS} small to prevent spikes.

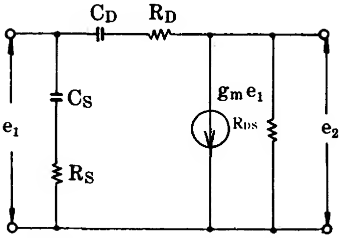
This equivalent circuit shows the characteristic of an FET very well, because it is related to the structure of an FET and it is shown by using basic parameters not depending on frequency.

As shown in the simplified equivalent circuit, for example, it is understood that DC input resistance (which is infinity) can be practically ignored and that C_D (internal feedback capacitance) is an unstable factor at high frequency.

At low frequency, it is possible to ignore capacitance; input resistance is infinity, while output resistance=R_{DS}. This is almost the equivalent circuit of a vacuum tube.



(a) Equivalent circuit



(b) Simplified equivalent circuit

Fig. 5 Equivalent circuit

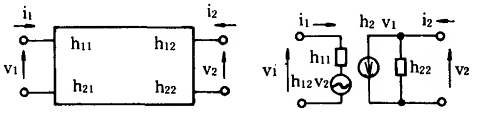
2. Circuit parameters

This is a method used to describe a transistor by regarding it as a four-terminal circuit network and by using the electrical characteristics of terminals irrespective of the physical characteristics of the transistor.

(1) Matrices showing the relation among the input and the output by voltage and current.

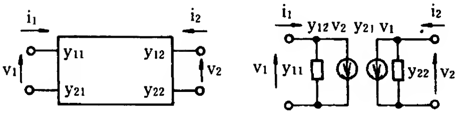
Those matrices have the six types shown in Table 1 (a, b, g, h, y, and z matrices). Among others, both"h"and"y"matrices are used comparatively often.

Fig. 6 and 7 show the definitions of"h"and"y" matrices. Classification between the common emitter and the common base is shown by using suffixes e or b after i, r, f, or o.



$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} h_i & h_r \\ h_f & h_o \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix}$$

Fig. 6 Circuit network by using "h" matrix



$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} y_i & y_r \\ y_f & y_o \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

Fig. 7 Circuit network by using "y" matrix

The physical meanings of each parameter in Figs. 6 and 7 are as follows:

h_i: input impedance
h_r: voltage feedback ratio
h_f: current gain
h_o: output admittance
y_i: input admittance
y_r: reverse transfer admittance
y_f: forward transfer admittance
y_o: output admittance

The h matrix are often used for the low-frequency regions, and y matrix for the high-frequency regions.

(2) Matrix showing the relation among the input and the output by power

Such phenomena as the reflection and transfer of waves in microwave circuits (such as waveguides and cavity resonators) are usually indicated by a "s" matrix (scattering matrix).

As the frequency limits for semiconductor products expand, the "s" matrix is occasionally used as a circuit paramater.

The definition of the "s" matrix is shown in Fig. 8; the physical meanings of each parameter are as follows:

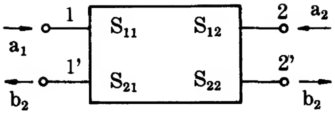
s_{11} : input reflection coefficient
s_{12} : reverse transfer coefficient

Table 3 Conversion of parameters

	[H]	[Y]	[S]
[H]	h_i h_r h_f h_o	$\frac{1}{y_i}$ $-\frac{y_r}{y_i}$ $\frac{y_f}{y_i}$ $\frac{y_i y_o - y_r y_f y_f}{y_i}$	$\frac{(1+s_o)(1+s_i)-s_r s_f}{(1-s_i)(1+s_o)+s_r s_f}$ $\frac{2s_r}{(1-s_i)(1+s_o)+s_r s_f}$ $\frac{-2s_f}{(1-s_i)(1+s_o)+s_r s_f}$ $\frac{(1-s_i)(1-s_o)-s_r s_f}{(1-s_i)(1+s_o)+s_r s_f}$
[Y]	$\frac{1}{h_i}$ $-\frac{h_r}{h_i}$ $\frac{h_f}{h_i}$ $\frac{h_i h_o - h_r h_f}{h_i}$	y_i y_r y_f y_o	$\frac{(1+s_o)(1-s_i)+s_r s_f}{(1+s_i)(1+s_o)-s_r s_f}$ $\frac{-2s_r}{(1+s_i)(1+s_o)-s_r s_f}$ $\frac{-2s_f}{(1+s_i)(1+s_o)-s_r s_f}$ $\frac{(1+s_i)(1-s_o)+s_r s_f}{(1+s_i)(1+s_o)-s_r s_f}$
[S]	$\frac{(h_i-1)(h_o+1)-h_r h_f}{(h_i+1)(h_o+1)-h_r h_f}$ $\frac{2h_r}{(h_i+1)(h_o+1)-h_r h_f}$ $\frac{-2h_f}{(h_i+1)(h_o+1)-h_r h_f}$ $\frac{(1+h_i)(1-h_o)+h_r h_f}{(h_i+1)(h_o+1)-h_r h_f}$	$\frac{(1-y_i)(1+y_o)+y_r y_f}{(1+y_i)(1+y_o)-y_r y_f}$ $\frac{-2y_r}{(1+y_i)(1+y_o)-y_r y_f}$ $\frac{-2y_f}{(1+y_i)(1+y_o)-y_r y_f}$ $\frac{(1+y_i)(1-y_o)+y_r y_f}{(1+y_i)(1+y_o)-y_r y_f}$	s_i s_r s_f s_o

S_{21} : forward transfer coefficient
S_{22} : output reflection coefficient

Suffix b or e is used to indicate the common base or the common emitter in the same manner as y parameters and h parameters.



$$\begin{pmatrix} b_1 \\ b_2 \end{pmatrix} = \begin{pmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix} = \begin{pmatrix} S_i & S_r \\ S_f & S_o \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

Fig. 8 Circuit network by using "s" matrix

Table 4 Conversion formulas for "h" parameters

		Converted "h" parameters		
		Common base	Common emitter	Common collector
Known "h" parameters	Common base		$\frac{h_{ib}}{1+h_{fb}}$ $\frac{\Delta h_b - h_{rb}}{1+h_{fb}}$ $\frac{-h_{fb}}{1+h_{fb}}$ $\frac{h_{ob}}{1+h_{fb}}$	$\frac{h_{ib}}{1+h_{fb}}$ 1 $\frac{-1}{1+h_{fb}}$ $\frac{h_{ob}}{1+h_{fb}}$
	Common emitter	$\frac{h_{ie}}{1+h_{fe}}$ $\frac{\Delta h_e - h_{re}}{1+h_{fe}}$ $\frac{-1}{1+h_{fe}}$ $\frac{h_{oe}}{1+h_{fe}}$		h_{ie} $1-h_{re}$ $-(1+h_{fe})$ h_{oe}
	Common collector	$\frac{-h_{ic}}{h_{fc}}$ $\frac{-\Delta h_c}{h_{fc}}-1$ $\frac{-(1+h_{fc})}{h_{fc}}$ $\frac{h_{oc}}{h_{fc}}$	h_{ic} $1-h_{rc}$ $-(1+h_{fc})$ h_{oc}	

$\Delta h_e = h_{ie} \cdot h_{oe} - h_{re} \cdot h_{fe}$, $\Delta h_b = h_{ib} \cdot h_{ob} - h_{rb} \cdot h_{fb}$, $\Delta h_c = h_{ic} \cdot h_{oc} - h_{rc} \cdot h_{fe}$

Table 5 Conversion formulas for "y" parameters

		Converted "y" parameters		
		Common base	Common emitter	Common collector
Known "y" parameters			Σy_b $-(y_{rb}+y_{ob})$ $-(y_{fb}+y_{ob})$ y_{ob}	Σy_b $-(y_{ib}+y_{ob})$ $-(y_{ib}+y_{rb})$ y_{ib}
		Σy_e $-(y_{re}+y_{oe})$ $-(y_{fe}+y_{oe})$ y_{oe}		y_{ie} $-(y_{ie}+y_{re})$ $-(y_{ie}+y_{oe})$ Σy_e
		y_{oc} $-(y_{fc}+y_{oc})$ $-(y_{rc}+y_{oc})$ Σy_c	y_{ic} $-(y_{ic}+y_{rc})$ $-(y_{ic}+y_{fc})$ Σy_c	

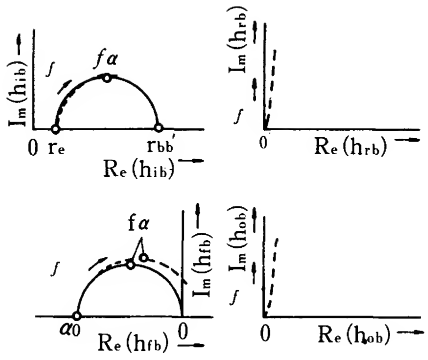
$\Sigma y_e = y_{ie} + y_{re} + y_{fe} + y_{oe}$
$\Sigma y_b = y_{ib} + y_{rb} + y_{fb} + y_{ob}$
$\Sigma y_c = y_{ic} + y_{rc} + y_{fc} + y_{oc}$

Table 6 "h" parameters converted by Early's T-type device parameters

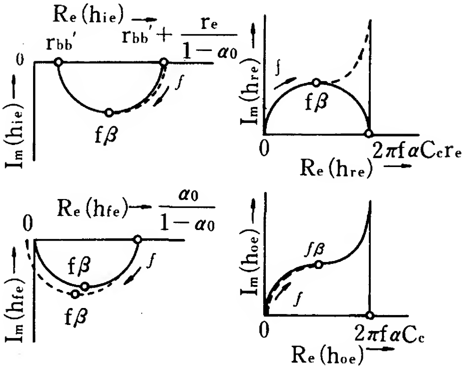
	Common base		Common emitter
h_{ib}	$\frac{r_e+r_{bb'}\left[(1-\alpha_0)+j\frac{f}{f\alpha}\right]}{1+j(f/f\alpha)}$	h_{ie}	$r_{bb'}+\frac{r_e}{(1-\alpha_0)+j(f/f\alpha)}$
h_{rb}	$j2\pi fC_c r_{bb'}$.	h_{re}	$2\pi f\alpha C_c r_e\frac{j\frac{f}{f\alpha}}{(1-\alpha_0)+j(f/f\alpha)}$
h_{fb}	$\frac{-\alpha_0}{1+j(f/f\alpha)}$	h_{fe}	$\frac{\alpha_0}{(1-\alpha_0)+j(f/f\alpha)}$
h_{ob}	$j2\pi fC_c$	h_{oe}	$2\pi f\alpha C_c\frac{j\frac{f}{f\alpha}(1+j\frac{f}{f\alpha})}{(1-\alpha_0)+j(f/f\alpha)}$

Table 7 "y" parameters converted by Early's T-type device parameters

	Common base		Common emitter
y_{ib}	$\frac{1+j\frac{f}{f\alpha}}{r_e+j\,r_{bb'}\frac{f}{f\alpha}}$	y_{ie}	$\frac{(1-\alpha_0)+j\frac{f}{f\alpha}}{r_e+jr_{bb'}\frac{f}{f\alpha}}$
y_{rb}	$-2\pi f\alpha C_c\frac{j\frac{f}{f\alpha}\left(1+j\frac{f}{f\alpha}\right)}{\frac{r_e}{r_{bb'}}+j\frac{f}{f\alpha}}$	y_{re}	$-2\pi f\alpha C_c\frac{r_e}{r_{bb'}}\frac{j\frac{f}{f\alpha}}{\frac{r_e}{r_{bb'}}+j\frac{f}{f\alpha}}$
y_{fb}	$-\frac{\alpha_0}{r_e+jr_{bb'}\frac{f}{f\alpha}}$	y_{fe}	$\frac{\alpha_0}{r_e+jr_{bb'}\frac{f}{f\alpha}}$
y_{ob}	$2\pi f\alpha C_c\frac{j\frac{f}{f\alpha}\left(1+\frac{r_e}{r_{bb'}}+j\frac{f}{f\alpha}\right)}{\frac{r_e}{r_{bb'}}+j\frac{f}{f\alpha}}$	y_{oe}	y_{ob}

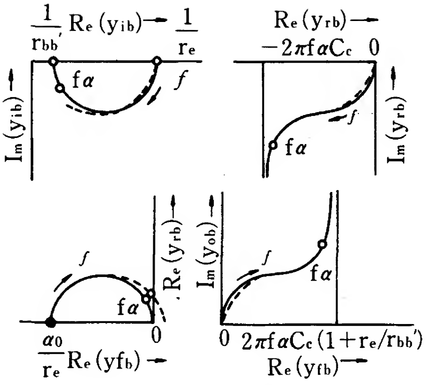


(1) Common base

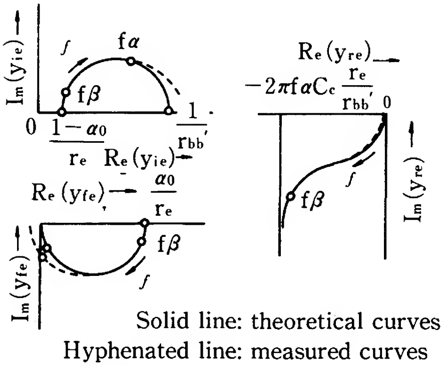


(2) Common emitter

Fig. 9 Frequency locus of "h" parameters



(1) Common base



(2) Common emitter

Fig. 10 Frequency locus of "y" parameters

Please refer to Tables 3, 4, and 5 for the correlation and conversion of common base and common emitter among circuit parameters. Fig. 9 and 10 shows the frequency locuses of "h" and "y" parameters obtained from Tables 6 and 7.

The above-mentioned parameters vary according to the operating points and temperature; thus, circuit designers should effect designing by comprehending the rough trends of such variations.

3. Low-frequency, low-noise amplifier circuit

(1) Design for low-noise amplifiers

It is necessary to carefully select the types and operating methods of transistors to be used when designing low-noise amplifiers. Voltage, current, and signal source impedance conditions to be operated should be fully checked and operate the transistors within the best noise characteristic range.

This section describes the concept of noise characteristics, the most suitable transistor conditions, and relations between the amplifier S/N ratio and the noise figure of transistors, so that circuits can be designed by fully utilizing the charactristics of low-noise transistors.

(2) Noise characteristics of transistors

The noise figures (NF) of transistors are represented by the equation

$$NF = 10 \log \left(\frac{Esi}{Eni} \Big/ \frac{Eso}{Eno} \right)^2 \quad \text{(dB)}$$

$$= 20\log\left(\frac{\mathrm{Esi}}{\sqrt{4\mathrm{kTRgB}}} \Big/ \frac{\mathrm{Eso}}{\mathrm{Eno}}\right)\ (\mathrm{dB}) \qquad \cdots\cdots (13)$$

Esi: input signal voltage
Eni: input noise voltage
Eso: output signal voltage
Eno: output noise voltage
k: Boltzmann's constant (1.38×10^{-23}J/°K)
$4kT=1.63\times10^{-20}$J
T: absolute temperature (°K)
Rg: signal source resistance
B: noise bandwidth
or Eni = 4kTRgB

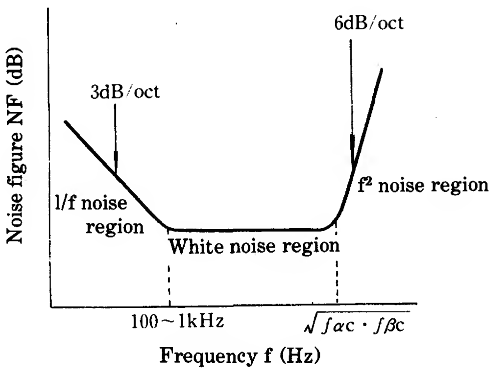


Fig. 11

Table 8

Items \ Types	1/f noise region	White noise region	f^2 noise region
Discription	Noise increasing in reverse proportion to frequency f	Constant noise irrespective of frequency	Noise increasing by 6 dB/oct in proportion to frequency f
Causes	Surface fluctuation	Thermal noise caused by base spreading resistance $r_{bb'}$	Fluctualtion by current separation
Suitability for audio application	○	○	×
Equalizer amplifier	◎	○	×

The relations between NF and the frequency is shown in the above figure. Noise characteristics are divided into ① 1/f noise region, ② white noise region, and ③ f^2 noise region, according to the frequency.

$$e_N = \sqrt{4kTR_NB}$$

$$i_N = \sqrt{2qI_bB}$$

Assuming that there is an ideal transistor possessing no noise sources, the above-mentioned noise figure (NF) can be represented as

$$\mathrm{NF} = 10\log\left(\frac{4kTRg+e_N{}^2+i_N{}^2Rg^2+2\gamma e_N\cdot i_N}{4kTRg}\right)\ (\mathrm{dB}) \qquad \cdots\cdots (14)$$

where, B=1 Hz, and γ:=correlated coefficient of e_N and i_N

This equation shows the relations between NF and e_N and i_N

It is evident from equation (14) that noise figure NF is dependent upon collector current Ic and signal source impedance Rg. Assuming that the total noise voltage= e_{NT},

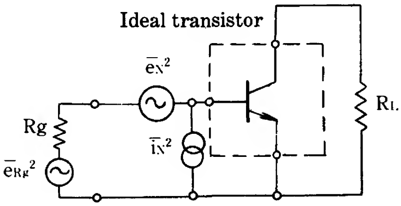


Fig. 12

Transistors can be identified by using the following voltage noise source e_N and current noise source i_N

$$\overline{e_{NT}}^2 = 4kTRg+\overline{e_N}^2+\overline{i_N}^2Rg^2+2\gamma e_N\cdot i_N \qquad \cdots\cdots (15)$$

Therefore, there is the following relationship between e_{NT} and signal source impedance Rg.

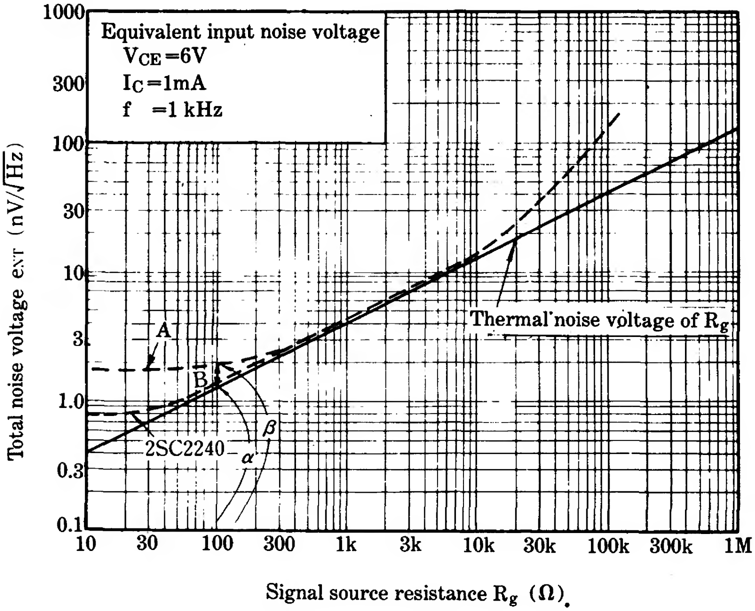
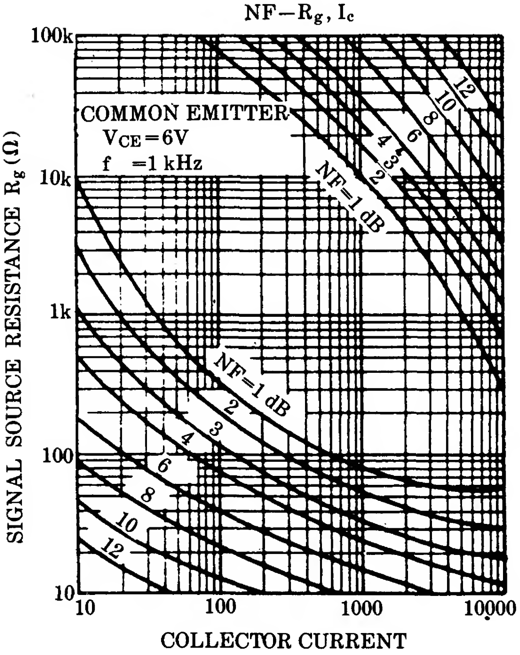


Fig. 13



(2SC2240) Fig. 14

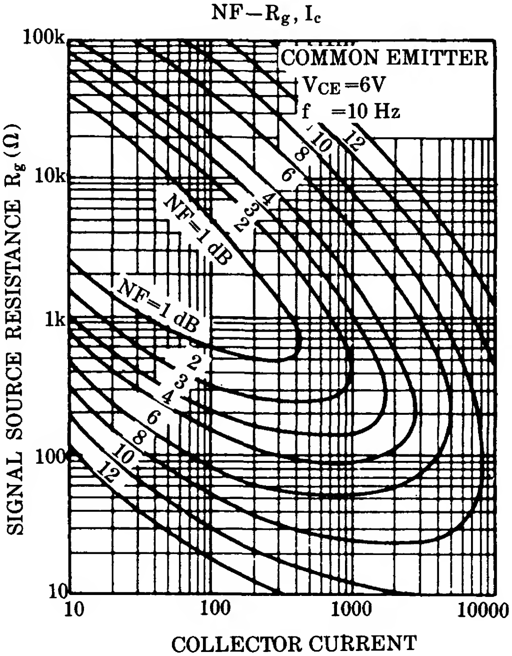


Fig. 15

When referring to the curve A in the figure of e_{NT}-Rg, NF can be represented by the difference B between the curve and the thermal noise voltageof Rg.

$NF=20\ (\log\beta-\log\alpha)$ corresponds to B in the above figure.

As is evident from equation (15), voltage noise plays the main role in those regions where signal source impedance Rg is small, while current noise plays the main role in those regions where Rg is large.

The figure termed an NF map, shown Fig. 14, Fig. 15, is obtained by adding the dependability of collector current to the graph of e_{NT}-Rg.

In this figure, contour lines of the NF are used to determine optimum operating conditions.

By referring to this NF map, the collector current Ic at which NFs at f=1 kHz and f=10 Hz are minimized is obtained by using the signal source impedance of a circuit to be used. When designing low-noise amplifiers, it is necessary to consider the conditions of circuits before and after them.

By referring to the foregoing description of NF, amplifier noise is explained in the next section.

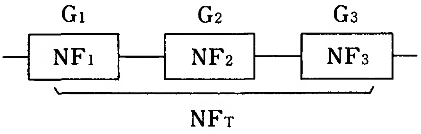


Fig. 16 NF of multistage amplifiers

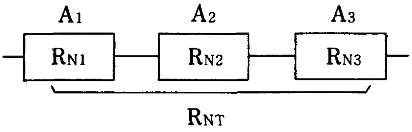


Fig. 17 Multistage amplifiers represented by using equivalent noise resistance

(3) Noise of amplifiers

The signal-to-noise ratio (S/N ratio) is an important factor in designing an amplifier.

$$S/N = 20\log\frac{\text{rated output voltage}}{\text{output noise voltage}}\ (\text{dB}) \quad \cdots\cdots\cdots\cdots (16)$$

From equation (13) for NF, equation (16) is connected with NF as follows:

$$\begin{aligned} S/N &= 20\log\frac{Eso}{Eno} \\ &= 10\log\frac{Eso^2}{Eno^2} \\ &= 10\log\left(\frac{Esi^2}{Eni^2}\cdot 10^{-\frac{NF}{10}}\right) \\ &= 10\log\frac{Esi^2}{4kTRgB} - NF \quad (\text{dB}) \end{aligned} \quad \cdots\cdots (17)$$

$$\boxed{\text{S/N ratio (dB) of amplifier}} = \boxed{\text{S/N ratio (dB) of Input-side}} - \boxed{\text{NF (dB) of Amplifier}}$$

(3-1) Noise figure of multistage amplifiers

The NF of the multistage amplifier shown in Fig. 16 is expressed as—

$$NF_T = NF_1 + \frac{NF_2-1}{G_1} + \frac{NF_3-1}{G_1\cdot G_2}\cdots \quad (18)$$

NF_T: total noise figure
NF1: first-stage noise figure
NF2: second-stage noise figure
NF3: third-stage noise figure
G1: first-stage power gain
G2: second-stage power gain
G3: third-stage power gain

When using equivalent noise resistance R_N, the R_{NT} is expressed as—

$$R_{NT} = R_{N1} + \frac{R_{N2}}{A_1} + \frac{R_{N3}}{(A_1 A_2)^2} \quad \cdots\cdots\cdots\cdots (19)$$

R_{NT}: total equivalent input noise resistance
R_{N1}: first-stage equivalent noise resistance
R_{N2}: second-stage equivalent noise resistance
R_{N3}: third-stage equivalent noise resistance
A_1: first-stage voltage gain
A_2: second-stage voltage gain

If the first-stage voltage gain G_1 is sufficiently large, the total noise figure NF_T is obtained as follows from equations (18):

$$NF_T \fallingdotseq NF_1 \cdots\cdots\cdots\cdots \quad (20)$$

Therefore, NF_T is determined by the NF of the transistor to be used at the first stage.

(3-2) Obtaining the noise figure of a circuit (NF_T) by using the NF of transistors

The NFs of transistors shown in catalogs are generally based on measurements at spot frequencies (such as 1 kHz, 100 Hz, and 10 Hz). They are not applicable without adjustment to such wide-bandwidth amplifiers as equalizer amplifiers in which low-frequency outputs are boosted.

Therefore, conversion is necessary by using the following method:

Since the f^2 noise region is related to high frequency, both the 1/f noise region and the white noise region are concerned with low-frequency amplification (see Fig. 11).

Assuming:

$\overline{e_g}^2$: mean square voltage of thermal noise produced by signal source resistance R_g

$\overline{e_w}^2$: mean square voltage of white noise

$\overline{e_{1/f}}^2$: mean square voltage of 1/f noise

and from the definition of a noise figure;

$$\text{NF (for white noise region)} = \frac{\overline{e_g}^2+\overline{e_w}^2}{\overline{e_g}^2}$$

$$= NF_{(1kHz)} \cdots\cdots\cdots\cdots \quad (21)$$

$NF_{(1kHz)}$ = NF at 1 kHz spot frequency

When obtaining $\overline{e_w}^2$ from equation (21):

$$\overline{e_w}^2 = (NF_{(1kHz)}-1)\,\overline{e_g}^2 \cdots\cdots\cdots \quad (22)$$

Assuming the noise figure at f=10 Hz to be $NF_{(10kHz)}$:

$$NF_{(10Hz)} = \frac{\overline{e_g}^2+\overline{e_w}^2+\overline{e_{1/f(10Hz)}}^2}{\overline{e_g}^2} \cdots\cdots \quad (23)$$

From equation (23),

$$\overline{e_{1/f}}^2{}_{(10Hz)} = (NF_{(10Hz)}-NF_{(1kHz)})\,\overline{e_g}^2 \cdots (24)$$

Since 1/f noise varies at the rate of 3 dB/oct with frequency, $\overline{e_{1/f}}^2$ at normal frequency is

$$\overline{e_{1/f}}^2 = (NF_{(10Hz)}-NF_{(1kHz)})\cdot\overline{e_g}^2\cdot\frac{10}{f}$$

$$\cdots\cdots\cdots\cdots\cdots\cdots \quad (25)$$

From equations (22) and (25), the total noise figure NF_T of an amplifier, whose frequency response and bandwidth are as shown in Fig. 18(a), (b), and (c), can be obtained from the equations

(a) Flat amplifier

$$NF_T = \frac{\int_{f1}^{f2}(\overline{e_g}^2+\overline{e_w}^2+\overline{e_{1/f}}^2)\,df}{\int_{f1}^{f2}\overline{e_g}^2 df}$$

$$= NF_{(1kHz)} + \frac{10\,(NF_{(10Hz)}-NF_{(1kHz)})\,\ell n\frac{f_2}{f_1}}{f_2-f_1}$$

$$\cdots\cdots\cdots\cdots \quad (26)$$

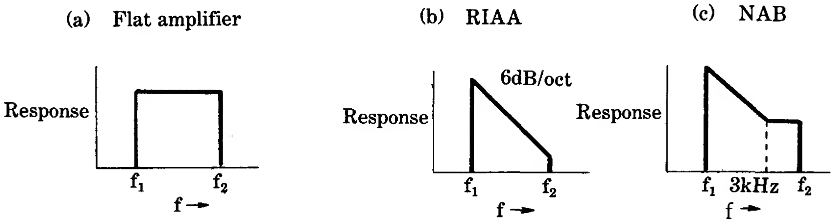


Fig. 18 Frequency response of wide-bandwidth amplifiers

(b) Equalizer amplifier (RIAA)

$$NF_T = \frac{\int_{f1}^{f2} (\bar{e}_g^2+\bar{e}_w^2+\bar{e}_{1/f}^2)\left(\frac{f_2}{f}\right)^2 df}{\int_{f1}^{f2} \bar{e}_g^2 \left(\frac{f_2}{f}\right)^2 df} \doteqdot NF_{(1kHz)} + \frac{5\left(NF_{(10Hz)} - NF_{(1kHz)}\right)}{f_1} \quad \cdots\cdots\cdots\cdots (27)$$

(c) Equalizer amplifier (NAB)

$$NF_T = \frac{\left\{\int_{f1}^{3kHz} (\bar{e}_g^2+\bar{e}_w^2+\bar{e}_{1/f}^2)\left(\frac{3kHz}{f}\right)^2 df + \int_{3kHz}^{f2} (\bar{e}_g^2+\bar{e}_w^2+\bar{e}_{1/f}^2)\, df\right\}}{\left\{\int_{f1}^{3kHz} \bar{e}_g^2 \left(\frac{3kHz}{f}\right)^2 df + \int_{3kHz}^{f2} \bar{e}_g^2 df\right\}}$$

$$\doteqdot NF_{(1kHz)} + \frac{5\left(NF_{(10Hz)} - NF_{(1kHz)}\right)}{f_1} + \frac{f_1}{(3kHz)^2}(f_2 - 3kHz)\, NF_{(1kHz)} \quad \cdots\cdots\cdots\cdots (28)$$

Fig. 19 shows an example of actual values calculated by using these equations. This figure shows how much the NF (l/f noise) at 10 Hz of a first-stage transistor influences a circuit in which the low-frequency region is boosted.

by substituting the wide-bandwidth noise figure NF_T thus obtained with that in equation (17), the S/N ratio can be calculated.

(4) Example of calculation of amplifier S/N ratio

By using the above-mentioned method, the S/N ratio of an amplifier using low-noise transistor 2SC2240 as the first-stage is calculated as

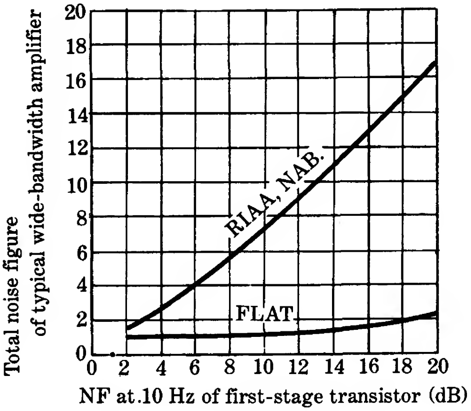


Fig. 19 Total noise figure of a typical wide-bandwidth amplifier

- Example of an amplifier

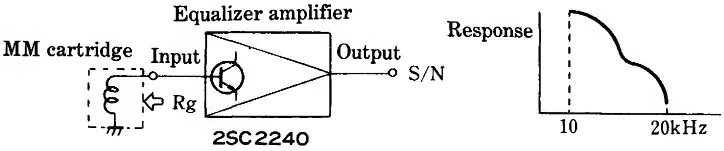


Fig. 20 Amplifier and typical frequency response

Signal source resistance (R_g): 2.2 kΩ at 1 kHz
Bandwidth (B): 10 ~ 20 kHz ≑ 20 kHz
Minimum input signal level (Esi): 2 mV
First-stage transistor: low-noise transistor 2SC2240
Frequency response: RIAA

Assuming that $I_c=100\mu A$ at $R_g=2.2k\Omega$ from the NF map of 2SC2240 above,

$$NF\ (1kHz) = 1.0\,dB$$

$$NF\ (10Hz) = 1.0\,dB$$

and from Fig. 19 and equation (17), (27)

$$S/N\ (dB) = 10\log\left\{\frac{(Esi)^2}{4kTRgB}\right\} - 1.0\ (dB)$$

$$= 10\log\left\{\frac{(2\times10^{-3})^2}{1.63\times10^{-20}\times2.2\times10^3\times20\times10^3}\right\}$$

$$-1.0$$

$$\fallingdotseq 67.5\ (dB) - 1.0\ (dB)$$

$$= 66.5\ (dB)$$

Thus, the S/N ratio of an amplifier in which 2SC2240 is used as the first-stage transistor is 66.5 (dB). However, IHF-A curve is not considered in this instance.

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2) J. WATSON: SEMICONDUCTOR CIRCUIT DESIGN, ADAM HILGER LTD. (1970)

4. Switching characteristics

This section refers to switching characteristics of a bipolar transistor. Should a pulse be supplied to the base in the circuit shown in Fig. 21, the waveforms of the base current and collector current are as shown in Fig. 22. Delay times of output waveforms to input waveforms, tr, tstg, and tf, in Fig. 22 represent switching times of the transistor. The terms tr, tstg, and tf represent rise time, storage time, and fall time respectively. Equations related to the switching characteristics of diffused base NPN transistors are generally expressed as

$$t_d \cong \frac{2}{I_{B1}}\left\{C_{TE}V_{BE}{}^{1/2}{}_{(OFF)} + C_{TC}\left[(V_{CC}{}^{1/2}+V_{BE(OFF)})^{1/2}-V_{CC}{}^{1/2}\right]\right\} \quad \cdots\cdots (29)$$

$$t_r = \tau_R h_{FE}\ \mathrm{In}\left[\frac{h_{FE}I_{B1}}{h_{FE}I_{B1}-0.9\,I_C}\right] \quad \cdots\cdots (30)$$

$$t_{stg} = \tau_S \mathrm{In}\left[\frac{h_{FE}(I_{B1}-I_{B2})}{I_C-h_{FE}I_{B2}}\right] \quad \cdots\cdots (31)$$

$$t_f = \tau_F h_{FE}\mathrm{In}\left[\frac{I_C-h_{FE}I_{B2}}{0.1\,I_C-h_{FE}I_{B2}}\right] \quad \cdots\cdots (32)$$

$$\tau_R \approx \tau_F \approx \frac{1}{2\pi f_T} + 1.7R_LC_{TC} \quad \cdots\cdots (33)$$

$$\tau_S \approx \frac{0.6}{2\pi f_b} + \frac{\tau_{nc}}{2} \quad \cdots\cdots (34)$$

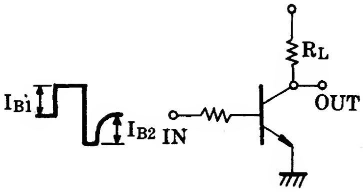


Fig. 21 Switching time measuring circuit

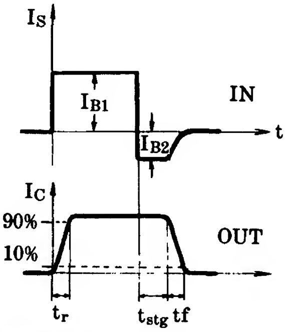


Fig. 22 Definition of switching waveform and switching time

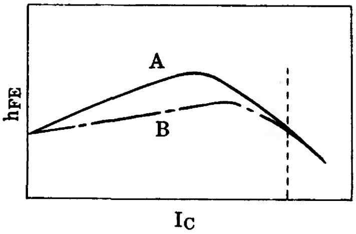


Fig. 23 I_C dependency of h_{FE}

where,

C_{TE} : emitter transition capacitance measured at $|V_{BE(OFF)} - \phi_0| = 1V$
ϕ_0 : contact potential difference at base-to-emitter junction
$V_{BE(OFF)}$: base-emitter voltage when transistor is off
C_{TC} : collector transition capacitance measured at V_{cc} $V_{BE(OFF)} << V_{cc}$
V_{cc} : collector supply voltage
h_{FE} : DC current gain at end of saturation region
f_T : transition frequency
f_b : base cutoff frequency
τ_{nc} : life time of minority carrier in collector layer

Consequently, it is possible to reduce td by reducing the emitter transition capacitance from equation (29) and tr by using the high driving circuit at high h_{FE}, and by increasing f_T from equation (30). tf can be reduced by lowering the switching current ratio (I_C/I_{B2}), though it will be elongated if h_{FE} is increased, in accordance with equation (32). It is evident from equation (31) that tstg is related to the recombination of minority carriers, and that life time of minority carriers in the base and collector regions are important factors. h_{FE} and tstg are in proportion to each other; therefore, it is acknowledged that very difficult technology is required to collectively speed up tr, tf, and tstg.

It is clear that equations from (30) to (32) are dependent upon h_{FE}. Though h_{FE} should be preferably kept small to lower the switching time, it must be large to reduce the drive energy when using a transistor. Thus, h_{FE} must be kept within a practical range.

When further research is conducted to improve this tradeoff as much as possible, the following method is found. Fig. 23 shows a collector current dependency of h_{FE}. Normally, there is a peak similar to A in Fig. 23. The peak of h_{FE} is often located on the low-current side from the operating point shown by a hyphenated line in that figure. h_{FE} at the operating point is fairly lower than that at the peak. When measuring the switching time at the operating point in the figure, it can be noticed that the switching time (especially t_{stg}) depends on h_{FE} at the peak more strongly than on that at the operating point.

By using this method, it is possible to lower the peak of h_{FE} without lowering h_{FE} at the operating point, by moving the peak of h_{FE} to a larger-current side (or the operating point side) as illustrated by line B. In other words, the problem is solved by making h_{FE} flat. To flatten h_{FE} coincides with the objective of the EPR structure in which the emitter is divided into minute portions (multi-emitter) to increase the effective area.

Then, research is conducted concerning equations (33) and (34) which are the logarithmic outer terms of equations (30) to (32). They include f_T and fb, the parameters representing frequency response of a transistor. Conventionally, increasing the base width and depth was unavoidable to increase the breakdown voltage and safe operating area, frequency response thus being sacrificed.

Since transition frequency f_T ($f_T < f_b$) amounts to some MHz, the first term of equation (33) and (34) is assumed to be 10^{-6} or 10^{-7}s. This means that by adopting an EPR structure based on high-frequency technology of power transistors, the frequency response can be improved by one digit or so. The second term of equation (33), a time constant based on collector transition capacitance and load resistance, is normally as small as 10^{-7} to 10^{-8}s. On the other hand, the second term of the equation (34) is as large as 10^{-6}s, the first and the second term thus being almost similar conventionally. As previously mentioned, this can be improved in a manner such as the first term being ignored with reference to the second term.

τnc in the second term can be controlled by introducing heavy metals called "life time killers" to the collector layer. By allowing the first term to be ignored, this controllability is much enhanced.

As already mentioned, switching time can be reduced by improving the large current characteristics of h_{FE} (termed "improving h_{FE} linearity") and by increasing the high-frequency response. This is realized by using the EPR structure in which a multi-emitter is used. For this reason, the EPR structure has been widely employed in switching transistors.

GPL structure employed in switching transistor

This section describes new transistors using a GPL structure, including an EPR structure.

Fig. 24 shows the FPR structure; Fig. 25 illustrates a section of the base-to-collector junction ends of this structure. The hyphenated lines in the figure illustrate base-to-collector junction is reverse-biased. It can be noticed that the depletion layer is narrower near the surface, and not bent in strict accordance with the junction line. This is caused by action of the positive charge contained in the thermally oxidized film (SiO_2), a protective film for the surface. Therefore, the electric field applied to the junction is increased near the surface, breakdown thus being evident there (applicable only to NPN transistors).

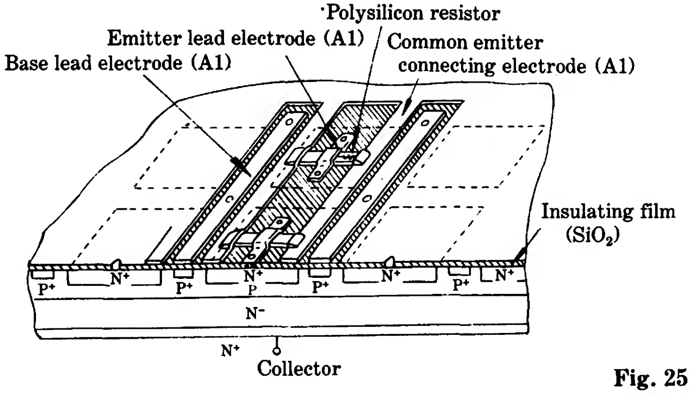

·Polysilicon resistor
Emitter lead electrode (A1)
Common emitter connecting electrode (A1)
Base lead electrode (A1)
Insulating film (SiO_2)
P+
N+
P+
N+
P
P+
N+
P+
N+
N-
N+
Collector

Fig. 24 EPR structure

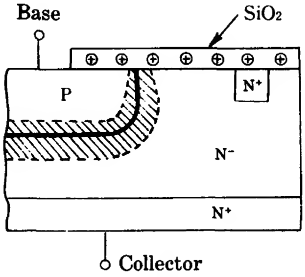


Fig. 25 Section of base-to-colector junction ends of EPR structure

In an ideal junction condition, breakdown voltage of the junction is determined by a concentration of impurities contained in the junction. It is known that even if the concentration of impurities is designed to assure high breakdown voltage, the objective is not achieved near the surface, as mentioned above.

To improve this condition, a new GPL structure is employed. Fig. 26 shows a schematic sectional view of the GPL structure. This structure is obtained by peeling off a thin layer of the Si surface near the junction, forming a glass film there almost flush with the surrounding surface, and introducing negative charges into the glass film. This expands the depletion layer near the surface to reduce the electric field, which in turn cause breakdown to occur in the inside junction, thus obtaining a higher breakdown voltage.

Fig. 27 shows a GPL structure actually employed in power transistors (V_{CEO}=800V) for switching regulators. The only difference between this and that in Fig. 26 is that a floating junction termed a "guard ring" is mounted outside the base junction. The reason is as follows: In Fig. 26, the curved portion of the inside junction (shown by the arrow) has a high electric field and determines the breakdown here. In Fig. 27, the same role is played by the curved portion of the guard ring whose voltage share is low, thus increasing the breakdwon voltage. By further mounting a double or a triple guard ring, breakdown voltage approaches the theoretical value. Then it is possible to obtain a withstand voltage exceeding 2,000V without difficulty.

The reason for adopting glass for the protective film is that it is possible to easily introduce a stable, controllable charge into the glass film and it is also possible to produce a film thick enough to prevent the internal electric field from leaking outside. The glass film is formed by using an electrophoretic method that selectively causes glass powder to adhere onto the chip and by burning at a high temperature.

Conventionally, high breakdown voltage was obtained by using a mesa structure, but the existence of mesa grooves rendered photoengraving of fine patterns rather difficult.

On the other hand, the GPL structure is feature of the realization of high breakdown voltage while using a planar structure to make a photoengraving of fine patterns as easy as those on IC's. As previously mentioned, the GPL structure is based on the technology of realizing higher breakdown voltage than that achieved by using an EPR structure in which fine patterns of a multi-emitter are used to produce high frequency and high output.

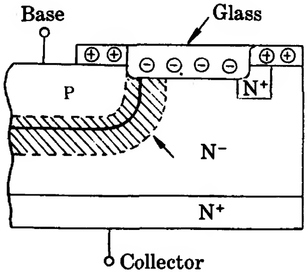


Fig. 26 Sectional view of base-to-collector junction end of basic GPL

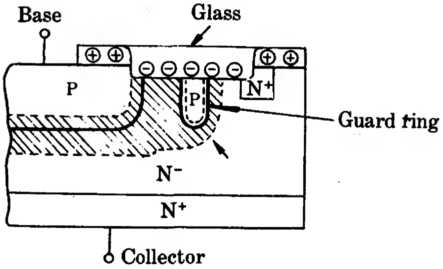


Fig. 27 Sectional view of base-to-collector junction end of GPL

Precautions for Handling Hybrid Application Devices

Hybrid application devices are small package and are assembled in a different method as compared with conventional TO-92, TO-92MOD, TO-126, and TO-220. This section describes general precautions for handling and other points on which users should take care.

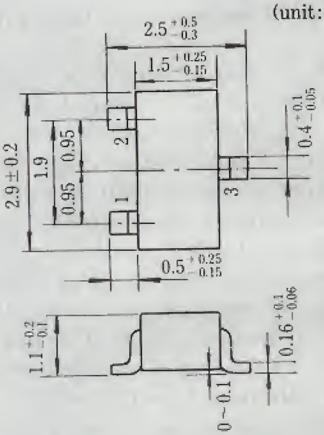
For further details, refer to the respective technical data.

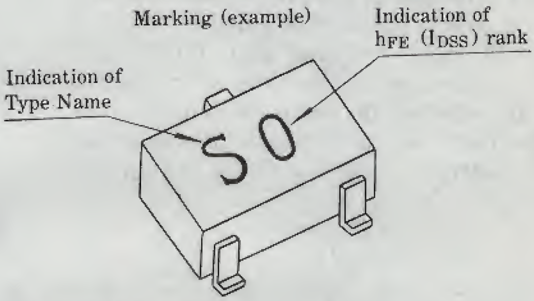
1. Hybrid application devices

Hybrid application devices are divided into the following three groups:

(1) Supermini-transistor (equivalent to TO-236)

Supermini-transistors are housed equivalents to TO-236 (SOT-23). Outline is shown in Fig. 1.

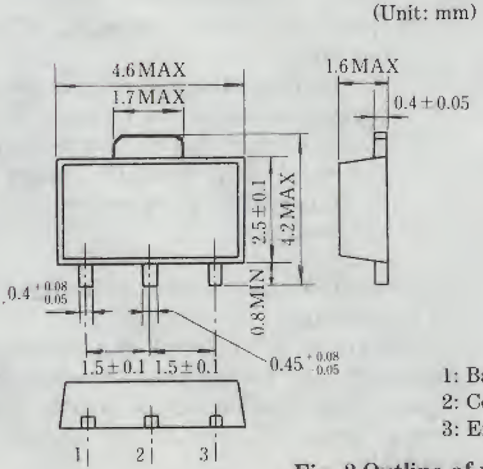


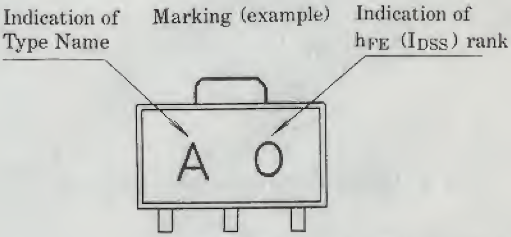


Electrode connection

Items	1	2	3
Transistor	Emitter	Base	Collector
2SK208/209	Drain	Source	Gate
2SK210/211	Gate	Drain	Source

Fig. 1 Outline of supermini-transistor





1: Base
2: Collector
3: Emitter

Fig. 2 Outline of power mini-transistor (equivalent to SOT-89)

(2) Power mini-transistor (equivalent to SOT-89)

Fig. 2 is outline of the power mini-transistor. The resin portion is small (2.5H × 4.5L × 1.5T, mm). Since the collector fin protrudes outside, it can be directly soldered to a ceramic substrate, making it possible to increase the collector Power Dissipation. This type of transistor is a flat package type in which the emitter, collector, and base leads are flush on the same surface to facilitate mounting on a ceramic substrate. Fig. 2 also shows a example of marking.

(3) Power mold transistor

Fig. 3 is outline of the power mold transistor. The resin portion is smaller (5.5H × 6.5L × 2.3T, mm) compared with TO-126 and TO-220, equivalent to this type of transistor. Since the collector fin protrudes outside, it is possible to increase the collector Power Dissipation by directly soldering the fin to a ceramic substrate.

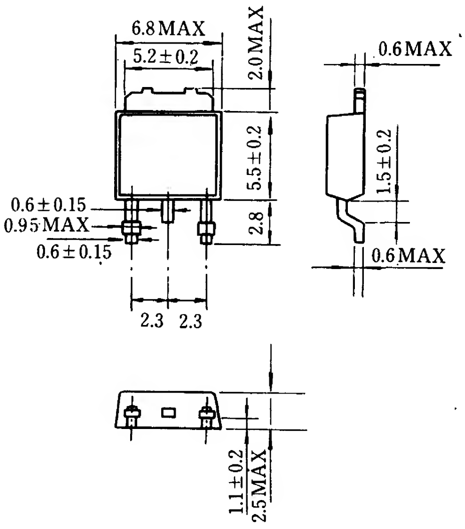


Fig. 3 Outline of power mold transistor

2. Precaution for handling

(1) General precaution

(a) Since the external resin portion of hybrid application devices is smaller compared with the housing of conventional devices of equivalent types, the hybrid application devices may sometimes be inferior to conventional types in humidity experiment. Therefore, it is necessary to coat the surface and surrounding units of such hybrid devices with resin or similar materials when using them under high-temperature, high-humidity conditions.

(b) Removing flux after soldering

After soldering a hybrid application device to a circuit board, flux which may have adhered while soldering or during the preflux treatment process must be removed. Should flux remain, rinsing is necessary because the flux component or compounds may cause a problem of lead wires corrosion. Do not attempt to remove inorganic flux by rinsing, because it can scarcely be rinsed off. Use of olefin cleaners such as Freon TE or Di-Freon Solvent S3-E is recommended.

(c) Handling of devices assembled with lead wires

Since the size of supermini-transistors is extremely small compared with other hybrid application devices, their lead wires may be deformed by slight force. Be careful concerning the following points.

- When mounting on a circuit board, do not handle the devices directly with the fingers; use a vacuum pincette or similar jig. By employing such a jig, the lead wire surface on which soldering is effected is kept free of oily contamination, thus facilitating soldering.
- Do not impart a force of 500g or more to the resin portion and lead wires while cleaning a circuit board; otherwise, lead wires may be deformed or disconnected and solderability will be reduced.
- Supersonic wave cleaning of circuit boards

  As far as possible avoid using supersonic wave cleaning when cleaning a circuit board. Should this method be unavoidably employed, clean the board for a short period in a supersonic wave bath of low output.

(2) Precautions on mounting procedures

Preheating

Preheating is required for power mini-transistors and power mold transistors prior to mounting them on circuit boards. The following types of preheating methods are available:

- Method of using a heater

Heat an device at 100~150°C/2 minutes by using an infrared heater or a heating panel (with built-in heater). Be careful to raise the temperature as slowly as possible; the semiconductor pellets may be damaged if the temperature rise is abrupt.

- Lamp heat radiating method

  This method utilizes a parabolic infrared lamp. Avoid an abrupt temperature rise, the same as in the mehtod above, by regulating the lamp focus and the power distance applied.

- Other method

  In addition to the foregoing are hot-air methods and others. If using these methods, preheat an element at 100~150°C for 2 minutes or similar conditions basically.

(3) Precautions on soldering process

(a) Allowable soldering time and temperature

The relation between allowable soldering time and temperature is as follows. Establish soldering conditions within these specifications.

- Supermini-transistors

  Soldering temperature... 260°C... 20 sec. or less (only one application allowed)

- Power mini-transistors and power mold transistor

  Soldering temperature... 250°C... 20 sec. or less (one each for preheating and soldering)

(b) Solder to be used

Be sure to use solder whose fusing point is as low as possible. The solder generally used is 6/3 or 6/4 solder with a fusing point of about 190°C. General soldering conditions include 220~240°C temperature and 3~5 seconds time.

When using creamy solder for printing by the metal mask method, use a newly mixed one as far as possible; be careful to avoid uneven printing or deformation. The recommended printing thickness of this solder printing is 200μm or more to improve lead wires solderability.

(c) Using a soldering iron

When using a soldering iron to mount an device on a circuit board, the device is often subjected to mislocation or package damage. Thus, it is recommended using a soldering iron only for experiments or repair. When using it, be careful about the following points:

- Temperature of soldering iron tip (for bonding): 250°C, 3 sec. or less
- Diameter of soldering iron tip: φ1 mm or less
- Do not allow the tip to contact the resin portions.

(d) Relationship between time and temperature for soldering and preheating

Figs. 4 and 5 show the relation between temperature and time for preheating and soldering in device mounting procedures such as the solder dip method.

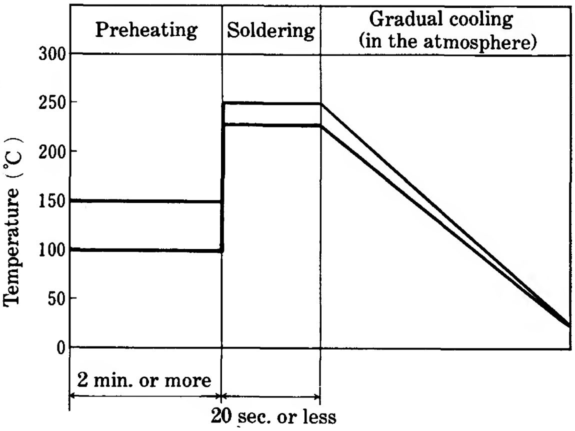


Fig. 4 Solder dip method

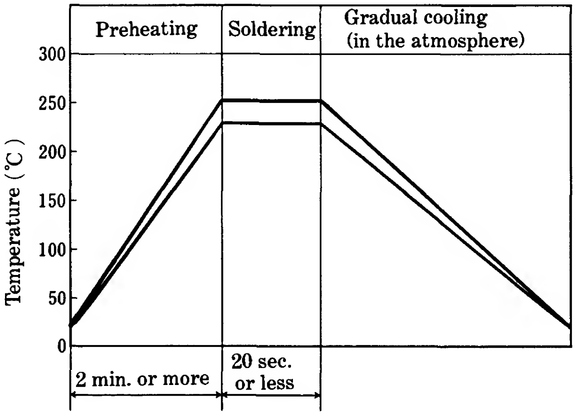


Fig. 5 Reflow soldering method (furnace soldering method)

(4) Precautions on allowable power dissipation (steady-state conditions)

The values of allowable power dissipation differ between an individual transistor and a transistor mounted on a circuit board. Changes in allowable power dissipation are described hereunder for typical models classified by their housing.

(a) Soupermini-transistor

Allowable power dissipation of supermini-transistors is 100~200 mW when they are used separately.

When mounted on a ceramic board, dissipation will be increased as shown in Fig. 4, in accordance with board sizes. The transistors used for this figure were 2SA1162/2SC2712.

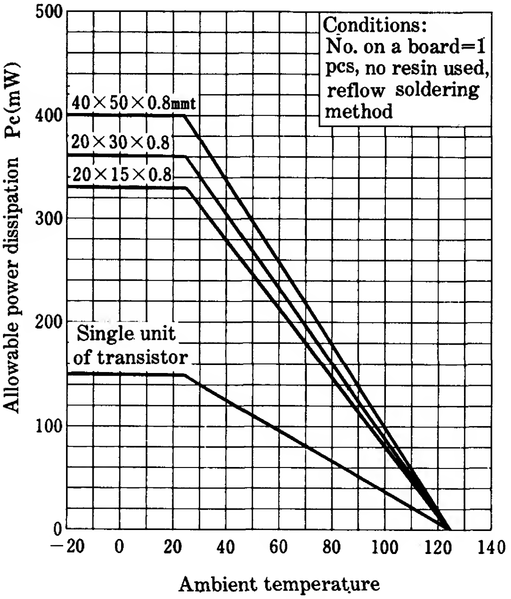


Fig. 6 Pc (max) — Ta characteristics of 2SA1162 and 2SC2712 mounted on an alumina ceramic substrate.

(b) Power mini-transistor

Being a small-sized housing, a power mini-transistor has an allowable power dissipation of 500 mW when used separately. When mounted on a board, however, it has an allowable power dissipation of a high 1.0W~2.0W because thermal diffusion from the collector fin to the board is increased. Therefore, it is possible to effect circuit designing similar to TO-92MOD (800~900 mW) and TO-126 (1.0~1.2W).

Fig. 5 illustrates examples of allowable power dissipation for the 2SC2873 and 2SA1213 mounted on a board.

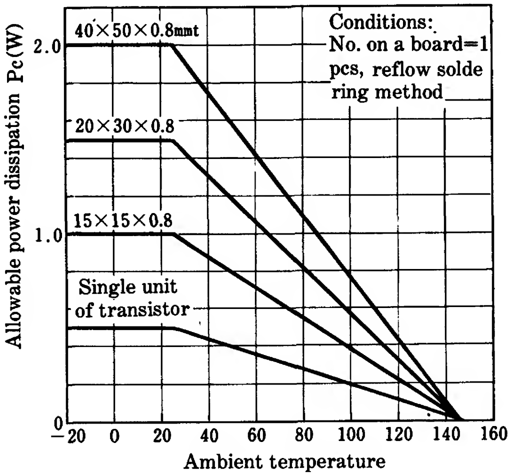


Fig. 7 Pc (max) — Ta characteristics of 2SC2873 and 2SA1213 mounted on an alumina ceramic substrate

(c) Power mold-transistor

Allowable power dissipation for the straight type is Pc=1W; however, that for the LB type is increased when mounted on a board through a collector fin. When soldering a power mold transistor to an alumina ceramic substrate, Pc(1) ($1000mm^2$) and Pc(2) ($2500mm^2$) are increased to 2W and 3W respectively. Fig. 8 shows the relation between the allowable power dissipation Pc and the ambient temperature Ta by using transistors 2SC3074 and 2SC1244.

(5) Precautions on allowable power dissipation (transient conditions)

When using a device for stroboscopic flash and motor driving circuits, the circuit design requires allowable power dissipation applicable to a short time in addition to allowable power dissipation under saturated conditions. Several types can be applied to such applications among Toshiba power mini-transistors and power mold-transistors. The relation between allowable power dissipation and pulse width under transient conditions for typical models for various packages is shown below:

(a) Power mini-transistor
Shown in Fig. 9.

(b) Power mold transistor
When using power mold transistors, it is also possible to take larger values of allowable power dissipation in a transient condition than in a saturated one. By using 2SC3074 and 2SA1244, the allowable power dissipation shown in Fig. 10 can be taken.

Be careful on the following points in this respect:

- Collector Power Dissipation Pc is a value within an area with restricted thermal resistance.
- The curve shown in he Figure is based on a single nonrepetitive pulse.

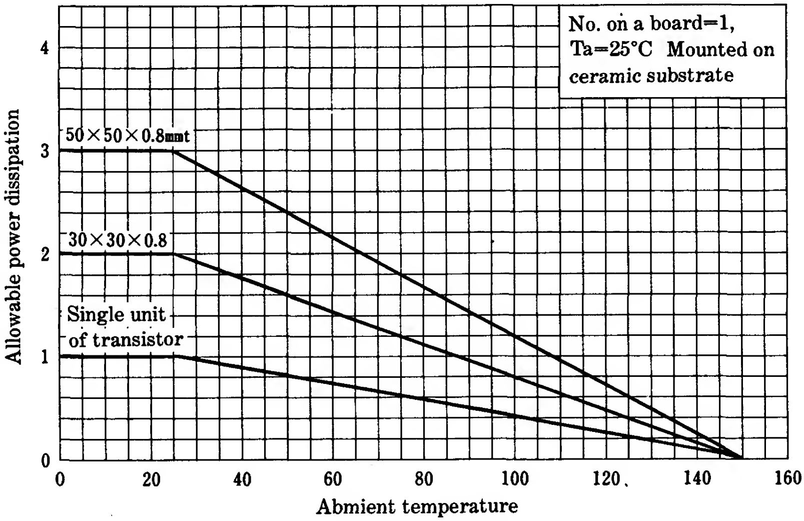


Fig. 8 Pc(max) — Ta characteristics of 2SC3074 and 2SA1244 mounted on an alumina ceramic substrate

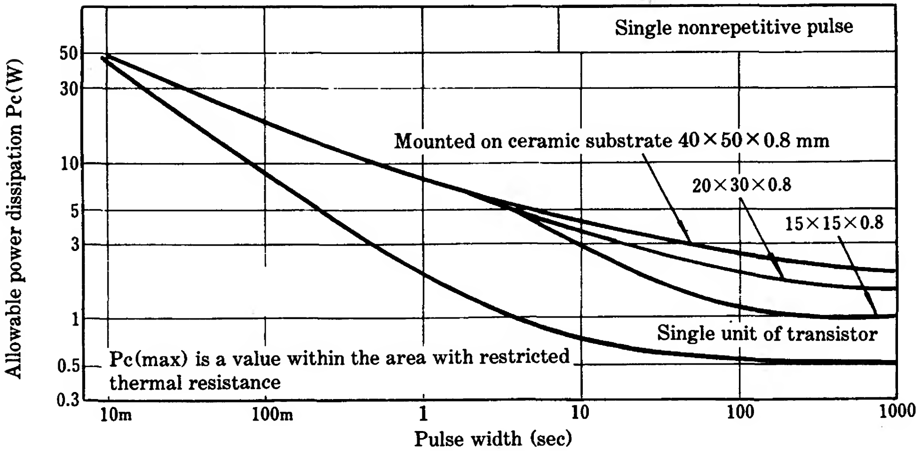


Fig. 9 Allowable power dissipation of 2SC2873 and 2SA1213 under transient conditions

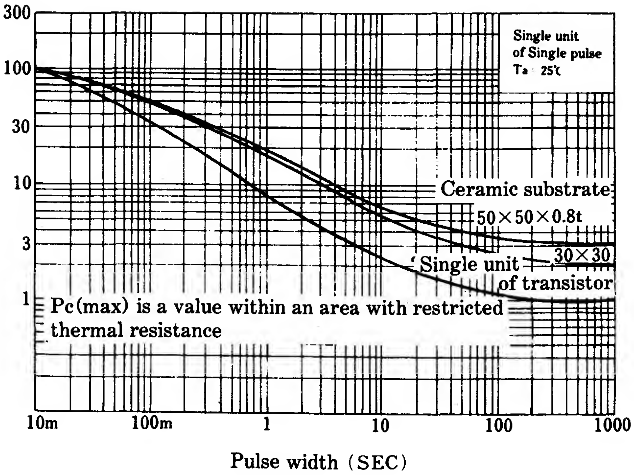


Fig. 10 Allowable power dissipation Pc—pulse width (2SC3074 and 2SA1244)

(6) Minimum pad size

(a) Supermini-transistor

Fig. 11 illustrates lead wire mounting locations and the minimum size of pads in supermini-transistors. Since the allowable power dissipation is substantially affected by the collector conducting pad area, it is advantageous to adopt a pad with as wide an area as possible, if the heat sink is taken into consideration.

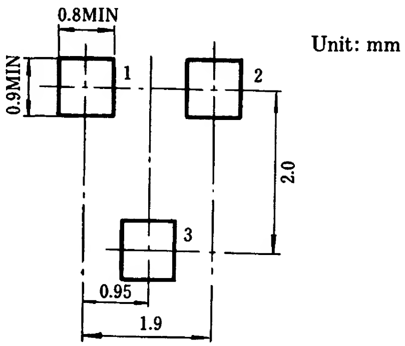


Fig. 11 Minimum size of mounting pad size for supermini-trasistors

(b) Power mini-transistor

Fig. 12 shows the lead wire mounting locations and the minimum size of pads in power mini-transistors. Since the allowable power dissipation is substantially affected by the collector connecting pad area, it is advantageous to adopt a pad with as wide an area as possible.

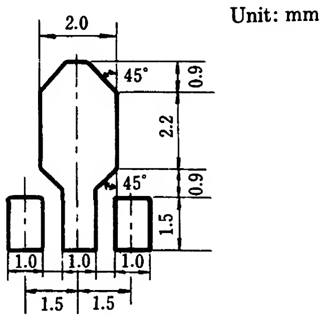


Fig. 12 Minimum pad size for power mini-transistors

(c) Power mold transistor

The thermal radiation of power mold transistors is effected mainly through a collector fin. If the area of conductor pattern connected to this portion is further increased, the allowable power dissipation is also increased. Thus, must be increase the conductor pattern size at the collector as much as possible. Shown in Fig. 13.

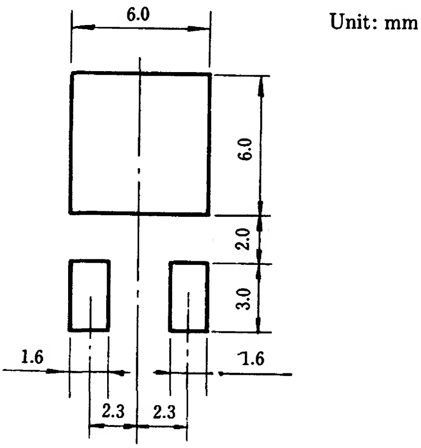


Fig. 13 Minimum pad size for Power-mold-transistor

Hybrid application devices, Group (1)

Supermini-Transistors (equivalent to TO-236)

*Transistor for microwave

Type Name	Application	Electrical characteristics (Ta=25°C)				Marking	Complementary Pair	Type Name similar to TO-92	Remarks (mini-transistor)
		V_{CEO} (V)	I_C (mA)	P_C (mW)	T_I (°C)				
2SA1162	General Purpose	−50	150	150	125	S	2SC2712	2SA1015	2SA1048
2SC2712	General Purpose	50	150	150	125	L	2SA1162	2SC1815	2SC2458
2SA1163	High Voltage Amp.	−120	−100	150	125	C	2SC2713	2SA 970	2SA1049
2SC2713	High Voltage Amp.	120	100	150	125	D	2SA1163	2SC2240	2SC2459
2SC2714	FM RF.	30	20	100	125	Q	—	2SC1923	2SC2668
2SC2715	AM CONV.	30	50	150	125	R	—	2SC380TM	2SC2669
2SC2716	AM RF.	30	100	150	125	F	—	2SC941TM	2SC2670
2SA1182	General Purpose	−30	−500	150	125	Z	2SC2859	2SA562TM	—
2SC2859	General Purpose	30	500	150	125	W	2SA1182	2SC1959	—
2SC2532	LED driver	40	300	150	125	AN	—	2SC 982	—
2SC2996	FM RF.	30	50	150	125	G	—	—	2SC2995
2SA1255	High-Voltage Amp.	−200	−50	150	125	O	2SC3138	—	—
2SC3138	High-Voltage Amp.	200	50	150	125	N	2SA1255	—	—
*2SC3011	UHF, C-Band RF.	7	30	150	125	MA	—	—	f_T =6.5GHz
*2SC3098	VHF, UHF RF.	20	50	150	125	MB	—	2SC2498	f_T =3.5GHz
*2SC3099	VHF, UHF RF.	20	30	150	125	MC	—	2SC2499	f_T =4GHz
*2SA1245	High-speed switching	−8	−30	150	125	MD	—	—	f_T =4GHz
2SC3119	UHF RF.	20	20	150	125	HA	—	—	f_T =900MHz
2SC3121	UHF OSC.	15	50	150	125	HC	—	—	f_T =1.3GHz
2SC3122	UHF RF.	30	20	150	125	HD	—	2SC2348	f_T =400MHz MIN.
2SC3123	VHF MIX.	20	50	150	125	HE	—	2SC3136	f_T =900MHz MIN.
2SC3124	VHF OSC.	15	50	150	125	HF	—	2SC2349	f_T =600MHz MIN.
2SC3125	PIF Stage	25	50	150	125	HH	—	2SC388ATM	f_T =350MHz

FETs

Type Name	Applications	V_{DSX} ** V_{GDO} V_{GDS} *(V)	Electrical characteristics (Ta=25°C)				Marking	Similar Type Name	Remarks
			I_C, I_D * (mA)	P_D (mW)	I_{DSS} (mA)	Yfs (ms)			
2SK208	General Purpose	−50	10	100	0.3~6.5	1.2MIN	J	2SK30ATM	
2SK209	General Purpose	−50	10	150	0.4~14	15	X	2SK117	
2SK210	FM RF, MIX.	−18*	10	100	3.0~24	7Typ.	Y	2SK192A	
2SK211	FM RF, MIX.	−18*	10	100	1.0~10	9Typ.	K	2SK241	
2SK302	FM RF, MIX.	20**	30*	150	1.5~14	10Typ.	T	2SK241	MOS FET

Diodes

Type Name	Applications	Electrical characteristics (Ta=25°C)					Marking	Similar Type Name	Remarks
		V_R (V)	I_P (mA)	C_T (PF)	NF(bB)	Rs(Ω)			
ISS154	UHF, S Band MIX.	6	30	0.8	9 MAX.	—	BA	—	
ISV128	VHF, UHF Attenator	50	50	0.25	—	7	BB	ISV99	

Hybrid application devices, Group (2)

Power mini-transistor (equivalent to SOT-89)

P_C; Mounted on ceramic substrate (250mm^2 × 0.8t)

Type Name	Application	Electrical characteristics (Ta=25°C)					Marking	Complementary Pair	Similar Type Name (TO-92MOD)	Remarks
		V_{CEO} (V)	I_C (A)	P_C (W)	P_C* (W)	T_j (°C)				
2SA1200	High-voltage switching	−150	−0.05	0.5	0.8	150	B	2SC2880	2SA949	
2SC2880	High-voltage switching	150	0.05	0.5	0.8	150	A	2SA1200	2SC2229	
2SA1201	Audio Driver Amp.	−120	−0.8	0.5	1.0	150	D	2SC2881	2SA965	
2SC2881	Audio Driver Amp.	120	0.8	0.5	1.0	150	C	2SA1201	2SC2235	
2SA1202	Audio Driver Amp.	− 80	−0.4	0.5	1.0	150	F	2SC2882	2SA817A	
2SC2882	Audio Driver Amp.	80	0.4	0.5	1.0	150	E	2SA1202	2SC1627A	
2SA1203	Power Switching	− 30	−1.5	0.5	1.0	150	H	2SC2883	2SA966	
2SC2883	Power Switching	30	1.5	0.5	1.0	150	G	2SA1203	2SC2236	
2SA1204	Power Switching	−30	−0.8	0.5	1.0	150	R	2SC2884	2SA950	
2SC2884	Power Switching	30	0.8	0.5	1.0	150	P	2SA1204	2SC2120	
2SA1213	Power Amp., power switching	−50	−2.0	0.5	1.0	150	N	2SC2873	2SA1020	Low $V_{CE(sat)}$
2SC2873	Power Amp., power switching	50	2.0	0.5	1.0	150	M	2SA1213	2SC2655	Low $V_{CE(sat)}$
2SC2982	Stroboscopic flash	10	2.0	0.5	1.0	150	S	—	2SC2500	Low $V_{CE(sat)}$
2SA1314	Stroboscopic flash	− 10	−2.0	0.5	1.0	150	T	—	2SA1160	Low $V_{CE(sat)}$
2SC3268	VHF～UHF RF.	12	0.07	0.5	0.8	150	UA	—	—	
2SC3301	VHF～UHF RF.	7.5	0.08	0.5	0.8	150	UB	—	—	

Hybrid application devices, Group (3)

Power mold-transistor

P_C*: @T_C=25°C **TO−92 MOD

Type Name	Application	Electrical characteristics (Ta=25°C)					Complementary Pair	Similar Type Name (TO-126, 220)	Remarks
		V_{CEO} (V)	I_C (A)	P_C (W)	P_C* (W)	T_j (°C)			
2SA1225	Audio Driver Amp.	−160	−1.5	1.0	10	150	2SC2983	2SA968	
2SC2983	Audio Driver Amp.	160	1.5	1.0	10	150	2SA1225	2SC2238	
2SA1241	Power Amp.	− 50	−2.0	1.0	10	150	2SC3076	2SA1020	
2SC3076	Power Amp.	50	2.0	1.0	10	150	2SA1241	2SC2655	
2SA1242	Stroboscopic flash	− 20	−5.0	1.0	10	150	2SC3072 Refer to h_{FE} classification	2SA1120	
2SC3072	Stroboscopic flash	20	5.0	1.0	10	150	2SA1242 Refer to h_{FE} classification	2SC2270	
2SA1243	Power Amp.	− 30	−3.0	1.0	10	150	2SC3073	2SA473	
2SC3073	Power Amp.	30	3.0	1.0	10	150	2SA1243	2SC1173	
2SA1244	High-current switching	− 50	−5.0	1.0	20	150	2SC3074	2SA1012	
2SC3074	High-current switching	50	5.0	1.0	20	150	2SA1244	2SC2562	
2SB 905	TV vertical output	−150	−1.5	1.0	10	150	2SD1220	2SA1021	
2SD1220	TV vertical output	150	1.5	1.0	10	150	2SB 905	2SC2481	
2SB 906	Power Amp.	− 60	−3.0	1.0	20	150	2SD1221	2SB834	
2SD1221	Power Amp.	60	3.0	1.0	20	150	2SB 906	2SD880	
2SB 907	Power Switching	− 40	−3.0	1.0	15	150	2SD1222	2SB677	Darlington Type
2SD1222	Power Switching	40	3.0	1.0	15	150	2SB 907	2SD687	Darlington Type
2SB 908	Power Switching	− 80	−4.0	1.0	15	150	2SD1223	2SB676	Darlington Type
2SD1223	Power Switching	80	4.0	4.0	15	150	2SB 908	2SD686	Darlington Type
2SD1224	Power Amp.	30	1.5	1.0	10	150	—	2SD549	Darlington Type
2SD1160	Motor control	50**	2.0	1.0	10	150	—	—	
2SC3075	High-voltage power Amp.	400	0.8	1.0	10	150	—	—	
2SC3303	High-current switching	80	5.0	1.0	20	150	—	2SC3258	
2SC3233	High-voltage switching	400	2.0	1.0	10	150	—	2SC2552	

**: V_{CES}

POWER MOS FET

To meet the demand for ideal switching devices ensuring high frequency, high breakdown voltage and high power, the POWER MOS FET has been developed as an device that is the nearest to the ideal.

In principle, FET operates by only majority carrier, and is not influenced by minority carrier, as seen in a bipolar transistor (especially, storage effect t_{stg} in switching and secondary breakdown region S/B). Fundamentally, MOS FET has higher input impedance than J-FET.

In addition, it is easy to handle for enhancement mode.

For these advantages, the bipolar transistor approaching the utmost of capacity is about to give its leading status to the POWER MOS FET.

There are POWER MOS FETs of different basic structure made by different techniques of various companies.

Ours is of double diffusion type to meet the technical rquirements of high reliability, high breakdown voltage, high speed and low cost, and has been named π-MOS FET for its basic structure (current flowing form).

1. Structure and Characteristics of π-MOS FET

(1) Basic structures of POWER MOS FET

The POWER MOS FET can roughly be classified into 3 kinds, as shown in Fig. 1.

(a) is an extension of the conventional small-signal MOS FET, and in this method, ion implantation technology is used in offset-gate structure and a high resistance layer is added, thus higher breakdown voltage being ensured.

This method has a disadvantage in respect of area efficiency (integration rate) because of its long channel length.

In (b), the gate is formed in V-groove (or U-groove) and the channel is formed by double diffusion and crystal anisotropic etching, thus higher breakdown voltage being ensured.

In this method, current concentration tends to occur at the groove end, and it is considered to be hard to attain higher breakdown voltage. The theoretical limit in high breakdown voltage and large current with regard to mass production has not reaches our target value.

In (c), the channel is formed by double diffusion, thus higher breakdown voltage being ensured. This is called D-MOS (Double Diffusion MOS).

As compared with the previous 2 methods, this is easy to ensure higher breakdown voltage and large current and also permits mass production at low cost.

Therefore, TOSHIBA used this D-MOS as basic structure and adopted a new guard ring structure for ensuring higher breakdown voltage and stability.

Obtaining high power and low ON resistance, such a fine processing technique as required for LSI is adopted to realize high efficiency.

(2) Structure of D-MOS

In the structure of the D-MOS, as shown in Fig. 1 (c), a base area to be served as channels by using the same diffusion window and a source area treated with high-concentration doping are diffused on a high resistance drain region, and a difference in diffusion depth between the two areas is used as channels.

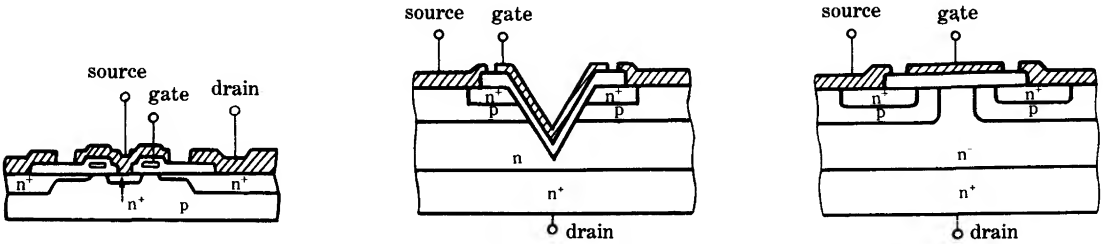
The distribution of impurities in the base drain junction thus formed is less on the drain side. The depletion layer extends more on the drain side when drain voltage is supplied, and less on the channel side, high breakdown voltage thus being ensured even in a very short channel, resulting from the punch-through preventing breakdown voltage from being decreased.

In addition, by employing a structure that takes the drain electrode from the base plate rear side, higher integration becomes possible, resulting in contributing to the realization of higher power. This also offers the merit of reducing transfer capacitance of the MOS FET by existance of cascade connected junction FET.

On the other hand, when effecting actual designing, it is necessary to fully consider the fact that a parasitic transistor exists between the source and the drain.

By adopting the basic structure of the D-MOS, it becomes possible to assure high breakdown voltage in the MOS EFT area; however, a new guard ring structure as shown in Fig. 2 is adopted to obtain higher breakdown voltage by determining breakdown voltage of the device at the chip peripheral areas.

Unlike conventional guard rings, this newly developed guard ring structure makes it possible for the breakdown voltage to be stabilized. This is facilitated by lowering the potential of each field plate through connecting guard rings to these field plates, in a greater degree as it reaches the outermost position, and also by reducing the potential of the outermost field plate to less than a predetermined value.



(a) Lateral MOS structure (b) V-groove MOS structure (c) Double diffusion MOS structure

Fig. 1 Basic Structures of Power MOS FET

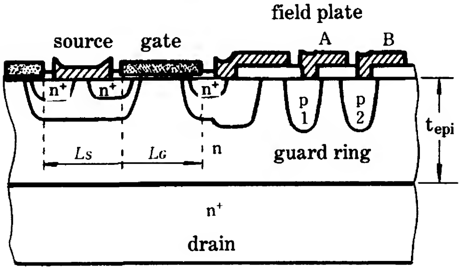


Fig. 2 New Guard Ring Structure

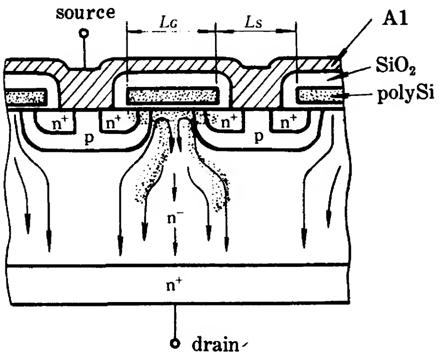


Fig. 3 Conceptional Diagram of Current Path within Exitaxial Layer

2. General Features of MOS FET

(1) The MOS FET is fundamentally a majority carrier device.

This differs much from the bipolar transistor that is a minority carrier device.

(2) Unlike the bipolar transistor that performs control by current, the MOS FET is a voltage-control device that performs control by voltage impressed between the gate and the source.

(3) As it is a majority carrier divice, it can provide high frequency switching operation without carrier storage effect.

Except in the case of special ultra-high frequency operation, it does not need such a carrier dumping circuit as required in the bipolar transistor.

(4) In the bipolar transistor, full derating is performed in using the device because junction destruction is caused by the secondary breakdown phenomenon that is explained in electric field concentration produced in a high voltage region.

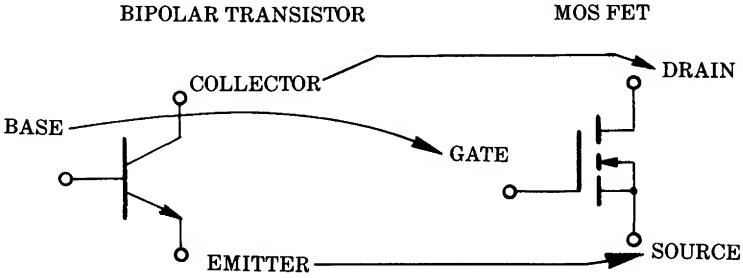
However, in the MOS FET, permission can be given to the nearly limit of the maximum rating.

(5) When the MOS FET is used in switching

operation, the switching time namely rise time t_r and fall time t_f are 1-figure faster than those of the bipolar transistor, and its turn-on and turn-off loss values are almost negligible.

In the MOS FET, the losses based on ON-resistance in switching are dominant, but the ON-resistance of the MOS FET has a positive temperature coefficient, so that the heat sink and heat radiation need to be designed in consideration of the ON-resistance at high temperature.

3. Definition of Terms



The names corresponding to those of the bipolar transistor are as shown by arrows in the above figure, but can not be compared as the same item, because the bipolar transistor is driven by current while the FET is driven by voltage. As main items for judging only the characteristics of the FET, the following can be mentioned.

- $|Yfs|$: Forward transfer admittance
  $|Yfs| = \Delta I_D/\Delta V_{GS}$ (S)
  This shows the sensitivity and amplifying capacity of the FET
- Vth: Gete threshold voltage
  This is the threshold voltage of MOS device, and is expressed by the gate-to-source voltage at a certain low operating current value (1 mA for π-MOS)
  Generally, at switching operation, it becomes:
  $V_{GS(OFF)} < Vth < V_{GS(ON)}$
- $R_{DS(ON)}$: Drain-source ON resistance
  This corresponds to $V_{CE(sat)}$ of the bipolar transistor, and serves as a criterion for finding self-dissipation in ON state.
  (It varies slightly with I_D.)
- $V_{DS(ON)}$: Drain-source ON voltage
  $R_{DS(ON)}$ applies to this item.
- Ciss, Crss, Coss: Capacitance
  This is influential in switching speed (available frequency) and becomes the capacitive load viewed from the driver stage.

As what corresponds to f_T in the bipolar transistor, the following figure of merit exists.

Figure of merit $= |Yfs|/Ciss$ (sec^{-1})

However, in general as theoretical cut-off frequency, the following is used:

$$f_{(MAX.)} = \frac{|Y_{fs}|}{2\pi(C_{iss}+A_V\cdot C_{rss})} \text{ (Hz)}$$

The other characteristics can be considered to be almost the same as those of the bipolar transistor. For details, refer to Chapter 10, list of terms for character symbols and graphic symbols.

4. Use of π-MOS FET

(1) Precautions for handling

TOSHIBA π-MOS FETs have much larger endurance for electric charge in comparison with small-signal MOS FETs and memories.

But π-MOS FETs can potentially be damaged and destroyed by electric charge, and please take the following precautions for handling.

(a) Transport and packing

- π-MOS FETs should be packed in conductive tray or pouch for MOS device, or in aluminum foil.

- π-MOS FETs should be handled by the package, not by the leads; especially, don't touch the gate terminals.
- It is recommended to perform operation on the conductive table mats being grounded as far as possible.

(b) Test and inspection

In addition to the above item, make sure of the added surge of the measuring apparatus, etc.

- Voltage application should be started from 0 and reset to 0 after measurement. (Each terminal)

  Especially, as for an automatic measuring apparatus, be particularly careful not to leave residual charge caused by the previous measurement.
- A 100-51 k ohm resistance should be connected in series with the gate to prevent oscillation.

  This value varies with the sensitivity of the measuring apparatus and measurement method.

(c) Mounting

- Soldering irons that are used for π-MOS FETs should be grounded.
- Possible shortest wiring should be performed to eliminate unnecessary inductance and oscillating factors.

(2) Example of absorber insertion

In case there is a possibility that surge may occur between the drain and the source, such absorbers as shown in Fig. 4 should be inserted.

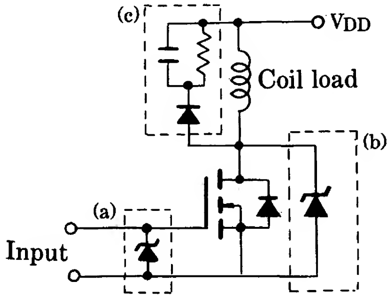


Fig. 4 Example of Absorber Insertion

(Recommended elements)

(a) For gate protection

($V_Z \leqq V_{GSS} \times 0.8 \sim 0.9$)

(b) For absorbing $V_{DS(surge)}$

Zener Diode: (attention to Psurge)

($V_Z \leqq V_{DSS} \times 0.8 \sim 0.9$)

(c) For absorbing coil counter electomotive power.

The same as in the case of a bipolar transistor circuit.

But, high speed response is required.

5. Electrical Characteristics of MOS FET

(1) Characteristic comparison with the bipolar transistor

See Table 1, 2.

6. Maximum Rating of MOS FET

(1) V_{DS} (V_{DSS}, V_{DSX}, V_{DSR}) MOS FET Drain-source breakdown voltage

The method prescribing drain-source breakdown voltage is classified into 3 kinds according to gate-source bias conditions.

V_{DSS}: Gate-source zero bias (shorted state)

V_{DSX}: Gate-source reverse bias; for example, in the case of N-channel MOS, $V_{GS}=-3$ V.

V_{DSR}: When shunt is made by resistance between the gate and the source.

As the π-MOS for industrial use is of complete enhancement type with a double diffusion structure, $V_{DSS}=V_{DSX}$ is obtained.

Even if drain-source breakdown voltage is measured by inserting a certain resistance between the gate and the source (V_{DSR} mode), it differs little from the V_{DSX} mode in magnitude and the expression of $V_{DSS}=V_{DSX}=V_{DSR}$ can be formularized.

Consequently, there is no method prescribing larger drain-source breakdown voltage than the value V_{DSX} prescribed as the maximum rating for the π-MOS.

Therefore, note that in circuit design there is a little difference from the way of thinking of the maximum rating of bipolar transistors.

For reference, the prescribed modes of maximum rating for bipolar transistors and their relations in magnitude are outlined below:

Table 1 Comparison of Power MOS FET with Bipolar transistor (Example: NPN Transistor, N Channel FET)

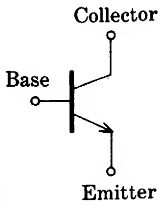
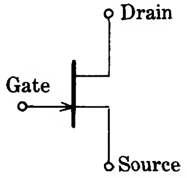
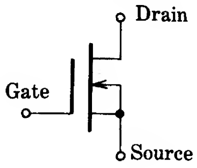
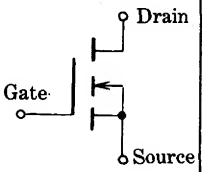
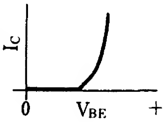
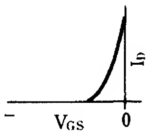
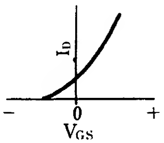
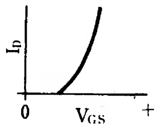
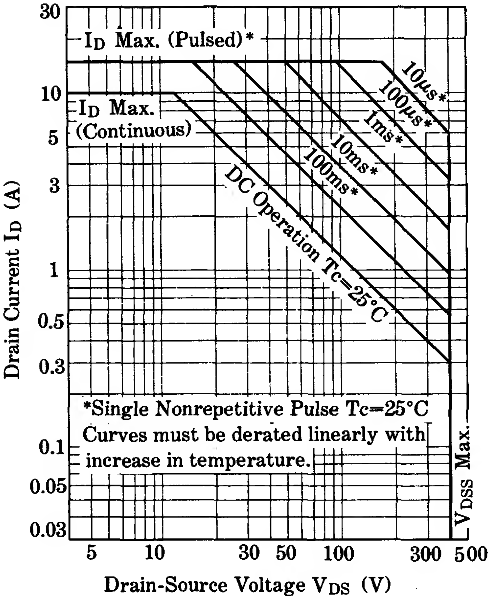
Transistor		FET (field effect transistor)			
		Type	Junction	MOS	
		Mode	Depletion	Depletion + Enhancement	Enhancement
NPN		N channel			
Input vs. Output characteristic		Input vs. Output characteristic			
Assurance of higher breakdown voltage	◎		△ Difficult	× Difficult	○ (π-MOS)
Assurance of higher power	◎		△	×	◎ (π-MOS)
ASO	S/B region exists	ASO	◎ Without secondary breakdown region (same class)		
Input impedance	× Low	Input impedance	○ High	◎ High	◎ High
Switching speed	△	Switching speed	◎ High speed	○ High speed	○ High speed
ON Resistance	◎ Low	ON -Resistance	○	△ High	○ (π-MOS)

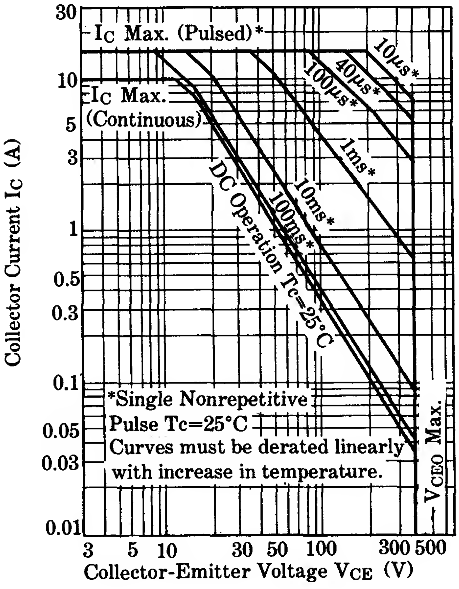
Table 2 Comparison of Main Characteristics between Power MOS FET and Bipolar Transistor

Specification of Power MOS FET				Specification of Bipolar Transistor			
Type No.		2SK324	2SK325	Type No.	2SC2914	Ultra-high speed transistor 2SC3384	2SD685 (Darlington transistor)
Maximum Rating	V_{DSS}	400V	450V	V_{CBO}	500V	500V	600V
				V_{CEO}	400V	400V	400V
	V_{GSS}	±20V	±20V	V_{EBO}	7V	7V	5V
	I_D	10A	10A	I_D	10A	15A	10A
	P_D	120W	120W	P_C	120W	120W	100W
Electrical Characteristics	$\lvert Y_{fs} \rvert$	5S(typ.)	5S(typ.)	h_{FE}	12	15	400
	$R_{DS(ON)}$	0.6Ω	0.7Ω	$V_{CE(sat)}$	1.0V	1.5V	2.0V
	V_{th}	1.5~3.5V	1.5~3.5V	$V_{BE(sat)}$	1.5V	1.5V	2.5V
	t_r	50ns(typ.)	50ns(typ.)	t_r	1μs	0.3μs	*1.0μs(typ.)
	t_{on}	80ns(typ.)	80ns(typ.)	*t_{on}			
	t_{off}	350ns(typ.)	350ns(typ.)	t_{stg}	2.5μs	1.5μs	12μs(typ.)
				tf	1μs	0.3μs	5μs(typ.)

π-MOS FET 2SK324



High Speed Switching Transistor 2SC2914



V_{CBO}: Collector-base breakdown voltage

V_{CEO}: Collector-emitter breakdown voltage (with base terminal open)

V_{CEX}: Collector-emitter breakdown voltage (base-emitter reverse bias; for example, in the case of NPN transistor, prescription of $V_{BE}=-1$ V, etc.)

Darlington Transistor 2SD685

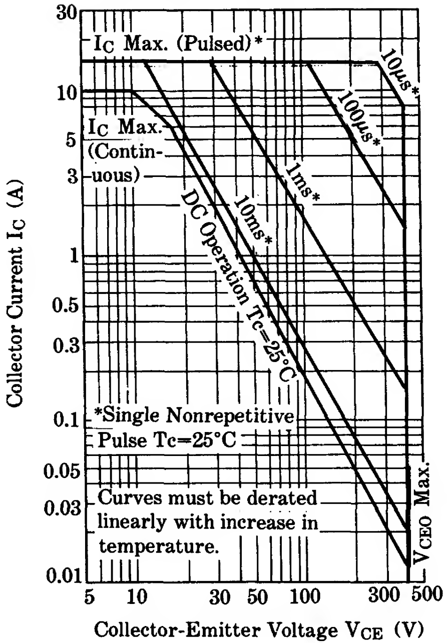


Fig. 5 Safe Operating Area

V_{CER}: Collector-emitter breakdown voltage (when shunt is made by resistance between the base and the emitter)

Their relations in magnitude vary with the bias voltage value between the base and the emitter or resistance values to be shunted, but generally, the following relations can be set up.

$V_{CBO} > V_{CEX} > V_{CER} > V_{CEO}$

In general bipolar transistor circuit design, the V_{CEO} is usually taken as standard for collector-emitter breakdown voltage.

Even if collector-emitter voltage momentarily exceeds V_{CEO} at a transient time such as switching operation, etc., it is maintained by the V_{CEX} mode or V_{CER} mode that is higher than the V_{CEO} in voltage, thus there being cases in which transistors are not destructed.

On the other hand, in designing a circuit using MOS FETs, the V_{DSX} should not be exceeded even momentarily, being considered to be the real maximum rating, as there is no higher drain-source breakdown voltage mode than it.

The V_{DSO} (with the gate open) should not be used, because it can easily be put in ON state by electrostatic induction with the very high impedance of the FET itself and consequently may destruct the device.

(2) V_{GSS}: Gate-source voltage

This is caused by breakdown voltage of gate oxide film. In the π-MOS, the maximum rating is ±20 V in consideration of service voltage and reliability. (Class for communication and industry application.)

The destruction point by surge is lowered as the chip is decreased in size, and great care should be taken in handling by referring to the previous item 4. (Use of π-MOS FET)

(3) I_D: Drain current

As for drain current I_D, the nominal value of Ta=25°C appears in the maximum rating items, but the following precautions should be taken in design and use.

- Temperature dependence:

$R_{DS(ON)}$ has a positive temperature coefficient as a general resistance element. (The absolute value and temperature coefficient vary with density.)

In addition, it fundamentally shows such an input vs. output characteristic as shown in Fig. 6, according to the temperature dependence of silicon mobility (the same as Junction FET).

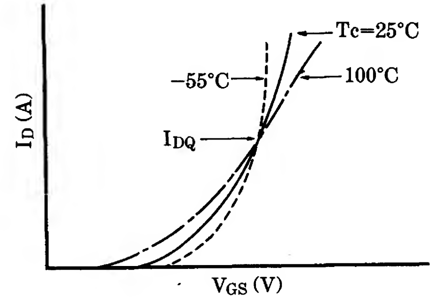


Fig. 6 I_D-V_{GS} Characteristic

Therefore, I_D shows positive and negative temperature coefficients with I_{DQ} as a boundary, and the operating point should be verified on the following points, especially, at fixed bias.

$I_D > I_{DQ}$ There is a possibility of destruction by overcurrent at low temperature.

$I_D < I_{DQ}$ There is a possibility of destruction by overcurrent and resultant thermal runaway.

Therefore, The maximum rating should be considered by derating according to temperature, including a temperature rise (change) by self-dissipation.

As countermeasures when abnormality occurs in a circuit, it is necessary to consider, for example, the saturation of inductive load (saturate with the transformer of switching power supply, and at lock of the motor, etc.)

With the saturation of inductive load, the load goes to low impedance and the device provides current to its capacity limit. This lead to destruction because of overcurrent or allowable power dissipation. If such a possibility exists, be sure to insert overcurrent limiting elements.

7. Switching Characteristic

The outstanding characteristic of the MOS FET as a majority carrier device is high speed and high frequency switching characteristic.

Because of this feature, it can be applied to high speed switching regulators (fo=100 kHz～300 kHz), broadcasting transmitters, motor controls, etc.

The cut-off frequency of the MOS FET reaches some GHz, but in practical circuits, it is limited by the parasitic resistance and input capacitance of the gate.

Fig. 7 shows the switching characteristic (drain current dependence of switching time when shunt is made by Rgs=50 Ω between the gate and the source) in the case of 2SK324.

In the measuring circuit shown in Fig. 7, there are prescribed rise time t_r, turn-on time t_{on}, fall time t_f and turn-off time t_{off} by the waveform of drain-source voltage V_{DS} when the positive pulse of $V_{GS}=10$ V is applied between the gate and the source. Essentially, there is no carrier storage effect in the MOS FET, and the storage time t_{stg} expressed in the bipolar transistor does not exist. However, there is delay time by the wiring capacitance and wiring inductance of pellet pattern, and its value is quantified as t_{off} for expression.

The MOS FET is drived by the voltage V_{GS} supplied between the gate and the source.

This drive facility is quantitatively expressed by $Q_{on}=C_{iss}\cdot V_G$ according to the charge accumulated at the gate.

The i_g (pulse) that transiently flows in charging is given by the following expression.

$$i_g\ (\text{pulse})=Q_{on}/t_{on}=C_{iss}\cdot V_G/t_{on}$$

Therefore, when the MOS FET is operated at a very high speed, a capacitance permitting this i_g (pulse) to flow rapidly and momentarily to the drive circuit is required.

In actual measurement, Miller-effect appears and the equivalent capacitance between the gate and the source increases by the corresponding reverse transfer capacitance Crss. Therefore, the Crss should be taken into account.

The criterion of drive conditions in this case is given by the following expression.

$$Q_{on}=(C_{iss}+A_v\cdot C_{rss})\cdot V_G$$

Moreover, the charging current i_g (pulse) that transiently flows is as follows.

$$i_g\ (\text{pulse})=(C_{iss}+A_v\cdot C_{rss})\cdot V_G/t_{on}$$
$$=C_{gs}\cdot V_G/t_{on}$$

In case the reverse transfer capacitance is comparatively large, the drive conditions should be set up in consideration of the item of Av·Crss. As shown in Fig. 8, the Crss has large voltage dependence to drain-source voltage V_{DS}.

When the depletion region begins spreading in the drain region just under the gate electrode, the Crss abruptly decreases; in the case of 2SK324, the capacitance decreases to about 1/10 around V_{DS}=2~5 V.

In this way, the switching speed of the MOS FET is determined by gate-source equivalent capacitance. Therefore, in setting up drive conditions, the graph of electrostatic capacitance $-V_{DS}$ characteristic shown in Fig. 8 becomes very important.

In the MOS FET, the t_r and t_f of switching time are determined by the time constant Rg·Cgs set by gate-source capacitance and the time constant set by series connection of signal source resistance Rg.

Fig. 9 shows the switching time—Rgs characteristic with the gate-source resistance Rgs varied.

If the Rgs is made larger, the time constant between the gate (terminal) and the source (terminal) is also made larger, so that the speed becomes low.

Like the bipolar transistor, the MOS FET can decrease switching time t_f and t_{off} by applying reverse bias between the gate and the source.

Fig. 10 shows the t_{off} and t_f characteristics with $+V_{GS}$=5 V fixed and $-V_{GS}$ varied from 0 V to 5 V.

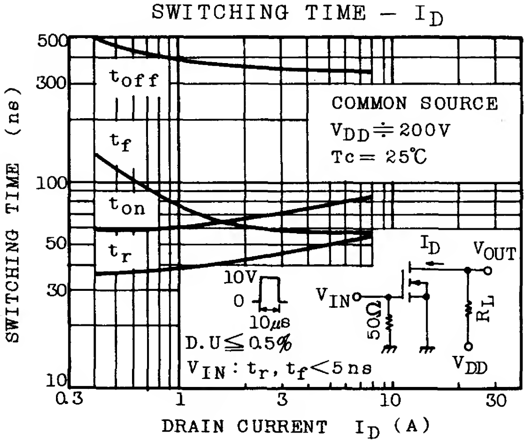


Fig. 7 Switching Time—I_D (in the case of 2SK324)

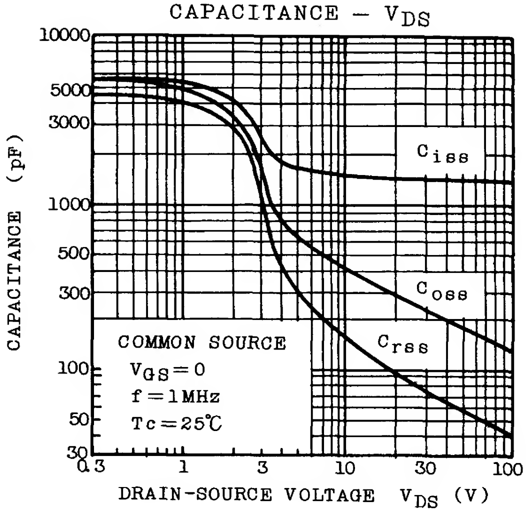


Fig. 8 Capacitance—V_{DS} (in the case of 2SK324)

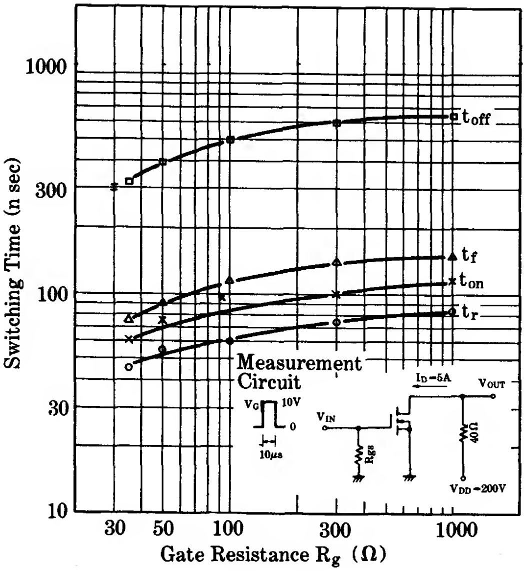


Fig. 9 Switching Time—Gate Resistance Rgs (in case of 2SK324)

As the switching speed of the MOS FET structurally depends on the capacitive charge and discharge phenomenon between the gate and the source, it is little influenced by switching time temperature as compared with the bipolar transistor.

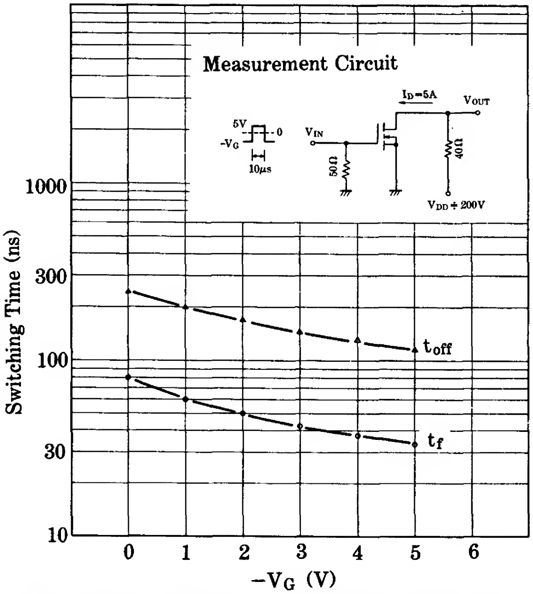


Fig. 10 Switching Time—I_D Characteristic (in the case of 2SK324)

Consequently, the use of MOS FETs in circuit design holds an advantage.

8. Forward Bias Safe Operating Area SOA

The MOS FET in principle presents such a secondary breakdown phenomenon in the high voltage region as seen in the bipolar transistor, for lack of current concentration.

Therefore, the forward bias safe operating area of the MOS FET is expressed with the pulse width as parameter by the equipotential line (inclination: −1) limited by thermal resistance, as shown in Fig. 5 (2SK324).

On the other hand, in case the bipolar transistor is used as switching element, great care is needed for load locus in design because of presence of secondary breakdown phenomenon. In the case of the MOS FET, it is possible to operate it very extensively and safely within the drain-source breakdown voltage without narrowing SOA in the high voltage region.

As for the derating of SOA by temperature rise, the derating rate in thermal limited area or $d_T=(T_{chmax}-Tc)/(T_{chmax}-25)$ is applied to all lines.

In thermal design, it is only required to consider that the channel temperature does not exceed the prescribed Tch (max.).

9. Reverse Bias Safe Operating Area SOA

In Case the switching device is applied for the use of power switching like switching regulator, etc., the load of the switching device becomes conductive.

In this case, both forward bias SOA and reverse bias SOA become significant. Therefore, in the case of the latest bipolar transistors, such a reverse bias SOA as shown in Fig. 11, with inductance L and base current I_{B1} and I_{B2} as parameters, is published.

Generally, in case the switching device is used for switching regulator, etc., the base-emitter junction is reversely biased forcedly and reverse current I_{B2} is caused to flow to decrease t_{stg} and t_f, in order to reduce a switching loss.

However, with I_{B2} increased, the reverse bias SOA narrows as shown in Fig. 11, and the operating area of the load locus at turn-off is limited.

On the other hand, t_f and t_{off} can be reduced by biasing reversely the gate-source, as described above.

At this time, in the MOS FET that is a majority carrier device, the reverse SOA does not becomes narrow by increasing $-V_{GS}$, because no carrier storage effect substantially exists.

It follows that in the use of MOS FETs, the safety degree in circuit design is increased.

10. Temperature Characteristic

The transfer characteristic (I_D-V_{GS} characteristic) of the MOS FET is shown in Fig. 12.

In the large current area, the temperature coefficient of the transfer characteristic is negative, the output changes, the internal temperature rises and gm $|Y_{fs}|$ goes down, so that a destructive phenomenon like thermal runaway is hard to occur without current concentration though a large drain current tries to flow.

On the other hand, in the small current area, the temperature coefficient is positive and the temperature coefficient of the transfer function changes from positive to negative with a crosspoint (I_{DQ}) as boundary.

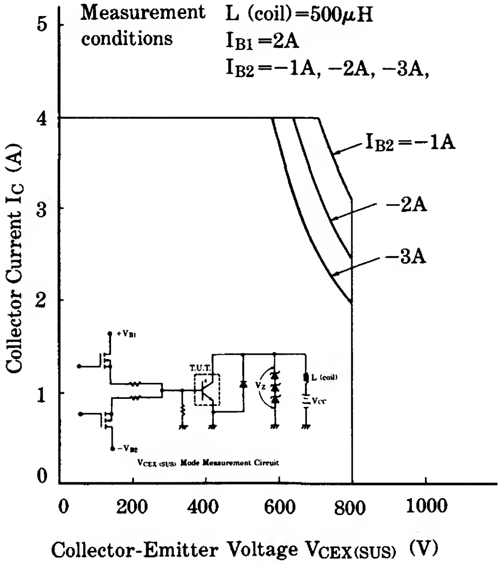


Fig. 11 Reverse Bias SOA Data of Bipolar Transistor (in case of 2SC2792)

Consequently, if the operating point is set to the crosspoint in an application circuit, any temperature compensating circuit is not needed.

In using the MOS FET, the item to consider with regard to temperature is the temperature dependence of drain to source ON resistance.

The ON resistance becomes about double with a temperature rise of 100 degrees.

(Refer to Fig. 13, $V_{DS\ (ON)}-Tc$ Characteristic.)

Therefore, in radiation design, the maximum temperature rise should be taken into consideration to select the heat sink, etc.

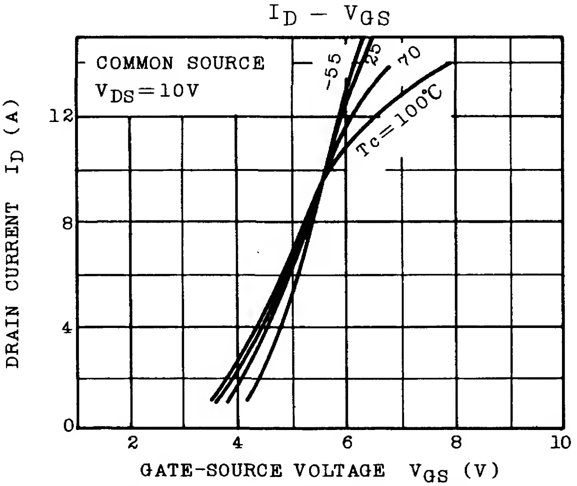


Fig. 12 I_D-V_{GS} Characteristic (in the case of 2SK324)

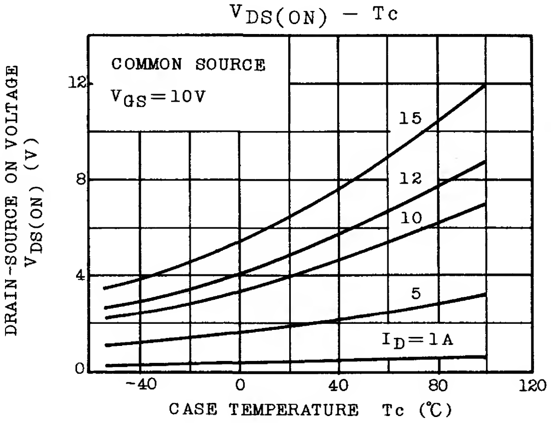


Fig. 13 $V_{DS\ (ON)}-Tc$ Characteristic (in the case of 2SK324)

11. Source-Drain Diode Characteristic

The MOS FET of D-MOS structure equivalently incorporates a diode between the source and the drain. The rating of forward current I_{DR} and the reverse breakdown voltage of this incorporated diode has the same capacity as the drain current I_D and drain-source voltage rating V_{DSX} of the MOS FET. But, as this incorporated diode is of 3-terminal including a gate terminal unlike common 2-terminal diodes (P-N junction), it shows some different forward characteristic according to the gate-source bias state.

Therefore, in application of the MOS FET, for example, in the bridge circuit of a switching regulator or motor control circuit (bridge type), it is fundamentally possible for this incorporated diode to be used as a commutation diode, but it is necessary to consider the fact that the forward characteristic varies with gate-source bias states.

If the gate-source is positively biased to form channels, the forward current of the diode flows in the same way as the drain current of the MOS FET, and in the small current region, linearity is established in the $I_{DR}-V_{DS}$ characteristic $(-V_{DS} \sim I_{DS} \times R_{ON})$ and $-V_{DS}$ becomes smaller than the forward voltage V_F of a general diode.

With a due application of the incorporated diode, it is possible to display the superiority of this 3-terminal diode.

12. Parallel Connection of MOS FET

It is often seen in circuits dealing with high power that versatile lower-cost devices are used in parallel connection.

In the case of bipolar transistors, as there is a secondary break-down phenomenon in the high voltage region, they are commonly used by the derating that the current per 1 transistor connected in parallel is 1/3 to 1/4 of the maximum collector rated current.

Considering a circuit dealing with high power with MOS FETs connected in parallel, the parallel connection of MOS FETs is very easy because there is no secondary breakdown phenomenon that is the greatest disadvantage of the bipolar transistor, and also it is possible to use them to the nearly limit of the maximum rating, so that the number of devices to be parallel-connected can be reduced. The advantages offered by the parallel connection of MOS FETs are outlined as follows.

1 Since the MOS FET is drived by gate-source voltage V_{GS}, its parallel connection is easily made. It hardly needs such a resistance that is inserted for base current balance in the parallel connection of bipolar transistors.

2 As there is a negative region in the temperature coefficient of drain current, the Tch of only a single MOS FET parallel-connected does not increase even if channel temperature Tch rises.

   In addition, temperature distribution is made uniform between parallel-connected devices, so that thermal runaway is hard occur in comparison with the bipolar transistor.

   Naturally, current concentration is hard to occur.

3 As there is no secondary breakdown region in the safe operating area of the MOS FET, it can be used to the limit of the maximum rating of drain current I_D and drain-source voltage V_{DS} as load locus ($I_D - V_{DS}$ waveform).

The above can be enumerated as the main advantages of the parallel connection of MOS FETs.

The switching time dispersion caused by the dispersion of V_{th} can particularly mentioned as a precaution for the parallel connection.

That is, the V_{th} can be considered to be a criterion of the voltage value at the outset of operation; the smaller V_{th} an device has, the more rapidly its turn-on becomes and the more slowly its turn-off becomes.

Therefore, in case a plural number of devices are used in parallel connection, devices with the same V_{th} value are needed. We are preparing 6 kinds of V_{th} as quasi-standard in your need.

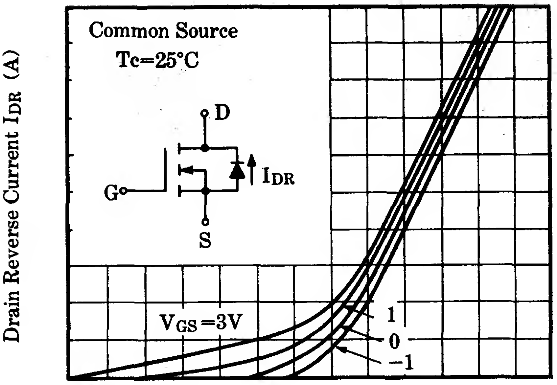


Fig. 14. $I_{DR}-V_{DS}$ Characteristic (in the case of 2SK324)

TOSHIBA POWER MOS FET V_{th} CLASSIFICATION

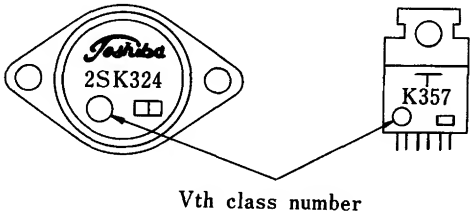
(For example, class for communication and industry device)

(1) Classification
(π-MOS FETs are classified into 6 classes according to gate threshold voltage V_{th}.)

(1) Classification

Class	V_{th} (V)	
	Min.	Max.
1	1.5	1.9
2	1.7	2.2
3	2.0	2.5
4	2.3	2.8
5	2.6	3.1
6	2.9	3.5

(2) Marking
Device:



Packing;
2SK324—○← classification number

(3) Packing
Pairs of same V_{th} class devices are packed.

(4) Remark
It is impossible to designate V_{th} class on the orders.

Precautions for Handling RF Power Transistor and Module

1. Precautions for handling RF PowerTransistor

(1) Mounting ceramic seal type transistor

For mounting such a transistor as shown in the figure, on a printed circuit board or heat sink, it is ncessary to adopt either the method of making the lead level (Fig. 2, (a)) or the method of bending the lead downward (Fig. (b)); it is prohibited to mount it in such a way that upward stress is given to the foot of the lead.

The lead should be bended at a 1—2 mm distance from the ceramic part.

Note that the gain is reduced by an increase of inductance of the emitter lead in the method shown in Fig. (b).

In mounting, press the transistor head lightly with a finger, hold it with a nut in the case of stud type or screw it in the case of flange type, and then solder the lead.

After soldering the lead, be careful not to give stress forcedly to the transistor.

In order to improve even a little the thermal contact state between the transistor and the heat sink, apply silicon grease with high thermal conductivity to the transistor bottom and stud screw in the case of stud type or to the flange bottom, screw mounting hole, etc. in the case of flange type.

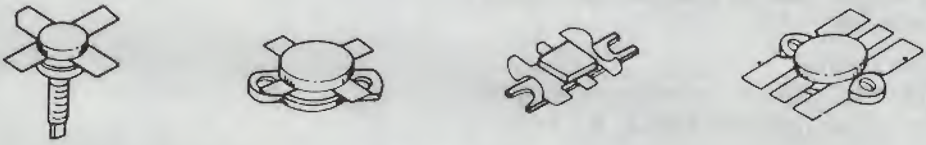
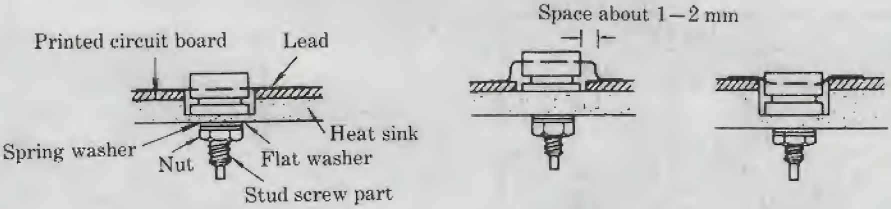


Fig. 1



(a) Correct (b) Correct (c) Incorrect

Fig. 2

(2) Screw stud torque

Excessive clamping of a transistor will not provide so much improvement of thermal resistance; on the contrary, it may cause damage to the screw part and lead and deformation to the surrounding unit and the inside of the pellet, deteriorating the characteristic.

On the other hand, if clamping is insufficient, thermal resistance naturally increases and the junction temperature of the transistor rises, resulting in destruction and a shorter life.

Table 1 shows the recommended clamping torque.

Table 1

Case Type	Stud parts	Stud torque
2-10G1A	M4 nut	5~6kg-cm
2-7A1A	M3 bis	〃
2-10H1A	〃	〃
2-13C1A	〃	〃
2-13B1A	〃	〃

(3) External base-emitter resistance

In order to improve the stability against load and power variations of land-mobile transmitters, a resistance may be used in series with the choke coil on the input side in a part of the power amplifier circuit, as shown in Fig. 3.

If this series resistance is too large, the transistor is so deeply biased to class C that larger voltage than base-emitter breakdown voltage is momentarily applied, thereby a deterioration of h_{FE} and then a drop of output power being caused while it is used for a long time.

Therefore, it should be designed to use a resistance of a possible minimum value.

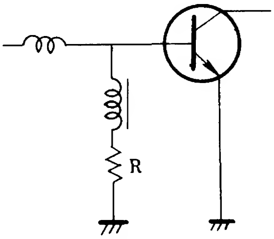
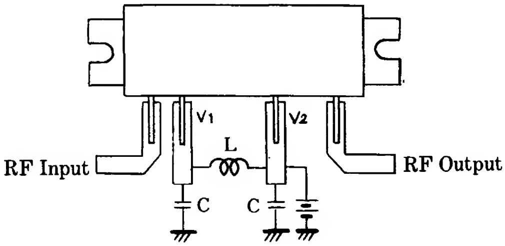


Fig. 3

(4) Treatment of wastse articles

Berylium oxide porcelain is used in RF power transistors (except those with the collector shorted to the case).

Berylium oxide (BeO), when transformed into powder or steam, does harm to a human body, incurring danger. Never produce neither powder nor steam by shaving, polishing, destroying, wiping with chemicals or buring the berylium oxide.



C: Parallel connection of 15000pF, 10 μF
L: ϕ 0.8 mm enamel wire, 8T, 5ID

Fig. 4

2. Precautions for Handling RF Power Amp Module

(1) Mounting Module

Use ϕ 4 mm screws and tighten them by a torque of 5 kg-cm—6 kg-cm. In order to improve the thermal contact state between the module and the heat sink as much as possible, be sure to apply silicon grease with good thermal conductivity on the rear side of the module radiation fin.

Don't give excessive mechanical and thermal stress to the lead terminal on the module.

The radiation fin of the moduel is connected to the ground.

In case the heat sink is grounded, good grounding effect can be obtained by clamp screws on both ends. In case only the printed circuit board is provided with ground, connect the radiation fin with the grounding electrode on the circuit board electrically by a metal plate that is as wide as possible.

(2) Prevention of oscillation by the RF feedback through DC line, etc.

For the prevention of oscillation by the RF feedback through DC line, connect L and C as shown in Fig. 4.

3. Thermal Design of RF Power Amp Module

(1) Thermal resistance and junction temperature of the used transistors

The RF Power Amp Mudule consists of 2-to-3-stage RF power transistor amplifiers.

Each stage is designed to permit operation under standard conditions of use so that the transistor junction temperature can leave a sufficient margin to the maximun rating (usually 175°C). The thermal design of the RF Power Amp Module S-AV5 for 144-148 MHz band 10 W amateur set is described below as an example.

(a) Operating state at nominal output

The nominal output of the S-AV5 is 15 W (P_i=0.2 W).

The total efficiency η_T is 50% MIN. Therefore, at the worst η_T, the total current I_T is:

$$I_T = \frac{P_O/\eta_T}{V_{CC}} = \frac{15/0.5}{12.5} = 2.4\ (A)$$

At this time, the I_C of the first-stage transistor and the last-stage transistor is approximately as follows.

$I_{C1}=0.39$ (A) $I_{C2}=2.01$ (A)

Moreover, at this time, the output of the first-stage transistor is approximately:

$P_{o1}=2.0$ (W)

(b) Thermal resistance of the used transistors

The standard junction-case thermal resistance value of each first-stage/last-stage transistor is as follows.

$R_{th\,j\text{-}c(1)}=10$ (°C/W) $R_{th\,j\text{-}c(2)}=3$ (°C/W)

(c) Junction temperature at nominal output

For the above (a) and (b), the transistor junction temperature at rated output is:

$T_{j(1)}=(V_{CC}\times I_{C1}-P_{o1}+P_i)\times R_{th\,j\text{-}c(1)}+T_C=38.8+T_C$ (°C)

$T_{j(2)}=(V_{CC}\times I_{C2}-P_o+P_{o1})\times R_{th\,j\text{-}c(2)}+T_C=36.4+T_C$ (°C)

where, T_C: case temperature

Table 2 shows a list of thermal design values for TOSHIBA RF Power Amp Modules.

(2) Heat sink and junction temperature

For designing a set with high reliability, it is necessary to mount it on a complete radiation fin under good conditions.

As a criterion, the thermal resistance of the radiation fin (Rth fin) is selected in order to that the case temperature Tc is below 90°C at the maximum ambient temperature (Ta max.).

As an example, the case of the aforementioned S-AV5 is described. Radiation fin required:

Supposing that Ta max is 60°C. When the rated output of the S-AV5 is 15 W, the worst efficiency is $\eta_{T\,MIN}$ 50%. Consequently, to make Tc below 90°C,

$$\begin{cases} T_C = \left(\dfrac{P_O}{\eta_T}-P_O+P_i\right)R_{th}f_{in}+T_{qmax}\leqq 90^\circ\mathrm{C} \\ R_{th}f_{in}\leqq 1.97\ (^\circ\mathrm{C}/\mathrm{W}) \end{cases}$$

Furthermore, when Tc=90°C, the junction temperature is:

$$\begin{cases} T_{j(1)}=30.8+T_C=120.8\ (^\circ\mathrm{C}) \\ T_{j(2)}=36.4+T_C=126.4\ (^\circ\mathrm{C}) \end{cases}$$

As for the other modules, the thermal resistance necessary to keep Tc≦90°C at Ta max=60°C is shown in Table 2.

Table 2 Thermal Design values and Radiation Fins Required of TOSHIBA RF Power Amp Modules

Item / Type	Module thermal design value (at rated output)																		Radiation fin required
			1st stage					2nd stage					3rd stage					
	P_o MIN (W)	η_T MIN (%)	I_c (A)	P_{o1} (W)	P_i (W)	$R_{th\,j\text{-}c}$ (°C/W)	$T_{j(1)}$ (°C)	I_{c2} (A)	P_{o2} (W)	P_{o1} (W)	$R_{th\,j\text{-}c}$ (°C/W)	$T_{j(2)}$ (°C)	I_{c3} (A)	P_{o3} (W)	P_{o2} (W)	$R_{th\,j\text{-}c}$ (°C/W)	$T_{j(3)}$ (°C)	R_{th} fin (°C/W)
S-AV5	15	50	0.39	2.0	0.2	10	30.8+Tc	2.01	15	2.0	3	56.4+Tc						1.97
S-AV6	28	45	0.78	3.7	0.2	8	50.0+Tc	4.20	28	3.7	2	56.4+Tc						0.87
S-AV7	28	45	0.78	3.7	0.2	8	50.0+Tc	4.20	28	3.7	2	56.4+Tc						0.87
S-AV8 (*)	17	40	0.35	1.5	0.07	10	29.5+Tc	2.45	14	1.5	2	36.3+Tc						1.42
S-AV9L,H	8	40	0.37	1.4	0.2	10	34.3+Tc	1.23	8	1.4	3	26.3+Tc						2.46
S-AV10L,H	14	40	0.45	2.3	0.2	10	35.3+Tc	2.35	14	2.3	3	53.0+Tc						1.42
S-AU3	15	40	0.46	2.0	0.2	10	39.5+Tc	2.54	15	2.0	2.6	48.8+Tc						1.32
S-AU4 (*)	17	35	0.45	2.0	0.12	10	37.5+Tc	2.75	14	2.0	2.2	49.2+Tc						1.15
S-AV5L,M,H	7	40	0.32	1.4	0.2	10	28.0+Tc	1.08	14	1.4	2.6	20.5+TC						2.80
S-AU6L,M,H	13	40	0.50	2.2	0.2	10	42.5+Tc	2.10	13	2.2	2.2	34.0+Tc						1.52
S-AU7	15	30	0.20	1.1	0.2	6	9.6+Tc	0.50	3.5	1.1	5.5	21.2+Tc	2.85	15	3.5	2	48.3+Tc	0.85

Note 1:
In (*)S-AV8 and S-AU4, Po is converted into a practical use level of 14 W, for thermal design vaue and radiation fin required.

Note 2:
The radiation fin required is a thermal resistance of the fin necessary for Tc≦90°C at Ta=60°C.

Letter Symbol and Graphical Symbol

1. Letter symbol

Table 1 General

Symbol	Description
NF	noise figure
P	allowable power dissipation
R_{th}	thermal resistance
$R_{th\,j\text{-}c}$	thermal resistance, (junction to case)
$R_{th\,j\text{-}s}$	thermal resistance, (junction to stud)
$R_{th\,j\text{-}a}$	thermal resistance, (junction to ambient)
$R_{th\text{-}(f\text{-}a)}$	thermal resistance, (heat sink to ambient)
$R_{th\text{-}(s\text{-}f)}$	thermal resistance, (stud to heat sink)
r_{th}	transient thermal resistance
T_a	ambient temperature
T_c	case temperature
T_j	junction temperature
T_{stg}	storage temperature
t_d	delay time
t_f	fall time
t_r	rise time
t_{rr}	reverse recovery time (diode)
t_{stg}	storage time
t_{on}	turn-on time
t_{off}	turn-off time

Table 2 Transistor

Symbol	Description
$V_{(BR)CBO}$	collector-base breakdown voltage, emitter open
$V_{(BR)CEO}$	collector-emitter breakdown voltage, base open
$V_{(BR)CER}$	collector-emitter breakdown voltage, with specified resistance between base and emitter
$V_{(BR)CES}$	collector-emitter breakdown voltage, with base short-circuited to emitter
$V_{(BR)CEX}$	collector-emitter breakdown voltage, with specified circuit between base and emitter
$V_{(BR)EBO}$	emitter-base breakdown voltage, collector open
b_{fb}	forward transfer susceptance, common base
b_{fe}	forward transfer susceptance, common emitter
b_{ib}	input susceptance, common base
b_{ie}	input susceptance, common emitter
b_{ob}	output susceptance, common base
b_{oe}	output susceptance, common emitter
C_{ob}	output capacitance, common base
C_{oe}	output capacitance, common emitter
C_{ib}	input capacitance, common base
C_{ie}	input capacitance, common emitter
$C_c\,r_{bb'}$	$C_c \times r_{bb'}$ (collector-to-base time constant)
C_{re}	reverse transfer capacitance
$f_{\alpha b}$	small-signal, short-circuit forward current transfer ratio cutoff frequency, common base
f_T	transistion frequency (common emitter gain band-width product)
G_c	conversion power gain
G_{pe}	power gain, common emitter
G_{ve}	voltage gain, common emitter
g_{fb}	forward transfer conductance, common base
g_{fe}	forward transfer conductance, common emitter
g_{ib}	input conductance, common base
g_{ie}	input conductance, common emitter
g_{ob}	output conductance, common base
g_{oe}	output conductance, common emitter
g_{rb}	reverse transfer conductance, common base
g_{re}	reverse transfer conductance, common emitter
h_{fb}	small-signal, short-circuit, forward current transfer ratio, common base
h_{fe}	small-signal, current gain, common emitter
h_{FE}	DC current gain, common emitter
h_{ib}	small-signal, short-circuit input impedance, common base
h_{ie}	small-signal, short-circuit input impedance, common emitter
$\mathrm{Re}(h_{ie})$	real part of small-signal, short-circuit input impedance, common emitter
$\mathrm{Im}(h_{ie})$	imaginary part of small-signal, short-circuit input impedance, common emitter
h_{oe}	small-signal, open-circuit output admittance, common emitter
h_{ob}	small-signal, open-circuit output admittance, common base
h_{rb}	small-signal, open circuit reverse voltage transfer ratio, common base
h_{re}	small-signal, open circuit reverse voltage transfer ratio, common emitter
I_B	base current
I_C	collector current
I_E	emitter current
I_{CBO}	collector cutoff current, emitter open
I_{CBV}	collector cutoff current, with specified reverse voltage between base and emitter
I_{CEO}	collector cutoff current, base open
I_{CEX}	collector cutoff current, with specified circuit between base and emitter
I_{EBO}	emitter cutoff current, collector open
KF	overall harmonic distortion
P_o	output power
P_i	input power
P_c	collector power dissipation
Q_s	stored charge
$r_{bb'}$	base spreading resistance
R_E	external emitter resistance
R_G	signal source resistance
R_i	input resistance
R_L	load resistance

R_o	output resistance
UMAPG	maximum available power gain
V_{BE}	base-emitter voltage
$V_{BE(sat)}$	base-emitter saturation voltage
V_{CB}	collector-base voltage
V_{CBO}	collector-base voltage, emitter open
V_{CBV}	collector-base voltage, with specified voltage between base and emitter
V_{CE}	collector-emitter voltage
V_{CEO}	collector-emitter voltage, base open
V_{CER}	collector-emitter voltage, with specified resistance between base and emitter
V_{CES}	collector-emitter voltage, with base short-circuited to emitter
V_{CEV}	collector-emitter voltage, with base specified voltage between base and emitter
V_{CEX}	collector-emitter voltage, with specified circuit between base and emitter
$V_{CE(sat)}$	collector-emitter saturation voltage
$V_{CE(sus)}$	collector-emitter sustaining voltage
V_{EBO}	emitter-base voltage, collector open
V_i	input voltage
V_N	noise voltage
V_R	reverse voltage
V_{osc}	oscillating output voltage
y_{fb}	forward transfer admittance, common base
y_{fe}	forward transfer admittance, common emitter
y_{rb}	reverse transfer admittance, common base
y_{re}	reverse transfer admittance, common emitter
θ_{fb}	phase angle of forward transfer admittance, common base
θ_{fe}	phase angle of forward transfer admittance, common emitter
θ_{rb}	phase angle of reverse transfer admittance, common base
θ_{re}	phase angle of reverse transfer admittance, common emitter

Table 3 Unijunction transistor

Symbol	Description
I_B	base current
$I_{B2(Mod)}$	modulated interbase current
I_E	emitter current
I_{EB20}	emitter reverse current, base 1 open
I_{EM}	peak emitter current
I_P	peak point emitter current
I_V	valley point emitter current
V_{B2B1}	base 2-base 1 voltage
V_{B1E0}	base 1-emitter voltage, with base 2 open
V_{B2E0}	base 2-emitter voltage, with base 1 open
V_{EB1}	emitter-base 1 voltage
$V_{EB1(sat)}$	emitter-base 1 forward saturation voltage, with specified voltage between bases 1 and 2
V_V	valley point emitter voltage
V_P	peak point emitter voltage
R_{BBO}	base 1-base 2 resistance, with emitter open instrinsic standoff ratio

Table 4 Field Effect Transistor (FET)

Symbol	Description
SOA	safe operating area
C_{G1D}	gate 1-drain capacitance
C_{G2D}	gate 2-drain capacitance
C_{is}	input capacitance, common source
C_{os}	output capacitance, common source
C_{rs}	reverse transfer capacitance, common source
C_{iss}	small-signal, short-circuit input capacitance, common source
C_{oss}	small-signal, short-circuit output capacitance, common source
C_{rss}	small-signal, short-circuit reverse transfer capacitance, common source
f_{opr}	operated frequency
G_{ps}	power gain, common source
GR	gain reduction
g_{iss}	input conductance, common source
g_{oss}	output conductance, common source
I_D	drain current
I_{DR}	drain reverse current (refer to measuring conditions)
$I_{D(OFF)}$	drain cutoff current
I_{DSS}	drain current, with gate short-circuited to source
I_{DSX}	drain-source current with specified circuit between gate and source
I_G	gate current
I_{GSS}	gate-source cutoff current, with source short-circuited to drain
I_{GSX}	gate excess current
NF	noise figure
P_D	drain power dissipation
$R_{DS(ON)}$	drain-source ON resistance, DC
$R_{DS(OFF)}$	drain-source OFF resistance, DC
$r_{DS(ON)}$	drain-source ON resistance, AC
$r_{ds(ON)}$	drain-source ON resistance, internal equivalent
r_G	gate resistance, internal equivalent
T_{ch}	channel temperature
T_j	junction temperature
T_{stg}	storage temperature range
$t_{d(on)}$	turn-on delay time
t_r	rise time
t_{on}	turn-on time
$t_{d(off)}$	turn-off delay time
t_f	fall time
t_{off}	turn-off time
$V_{DS(ON)}$	drain-source ON voltage
V_{DSX}	drain-source voltage with specified circuit between gate and source
V_{DSF}	drain-source forward transfer voltage
V_{DSS}	drain-source voltage, with gate short-circuited to source
V_{emf}	drain-source thermal electromotive force
V_{GS}	gate-source voltage
$V_{GS(OFF)}$	gate-source cutoff voltage
V_{GSS}	gate-source voltage, with drain short-circuited to source
V_{GDS}	gate-drain voltage, with source short-circuited to drain

$V_{(BR)DSS}$	drain-source breakdown voltage
$V_{(BR)GDS}$	gate-drain breakdown voltage
V_N	noise voltage
$V_{N(p-p)}$	peak-peak noise voltage
$V_{N(AV)}$	average noise voltage
V_{th}	gate-source threshold voltage
$\lvert Y_{fs} \rvert$	forward transfer admittance
y_{fs}	forward transfer admittance, common source
y_{is}	input admittance, common source
y_{rs}	reverse transfer admittance, common source
y_{os}	output admittance, common source

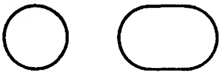
2. Graphical symbol

- Letters and numbers shown on the drawings of graphical symbols listed below are given only for explanation purposes and do not comprise a part of relevent symbols.

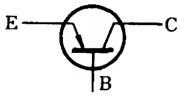
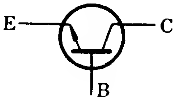
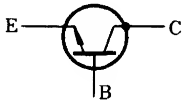
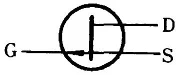
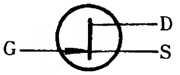
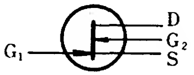
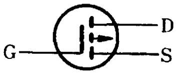
The letters used here denote the following—

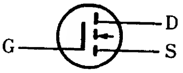
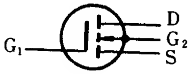
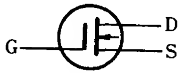
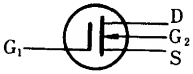
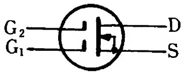
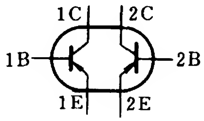
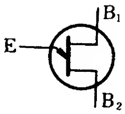
E: emitter	D: drain
C: collector	G: gate
B: base	S: source

- The following envelope symbols may be omitted if no confusion will arise or if none of the elements in a device is connected to an envelope.



Envelope Symbols

Description	Graphical symbol
PNP transistor	
NPN transistor	
NPN transistor (collector to case connected)	
P-channel junction type field effect transistor	
N-channel junction type field effect transistor	
N-channel junction type field effect transistor (gate taken out of a substrate)	
P-channel MOS enhancement type field effect transistor	

Description	Graphical symbol
N-channel MOS enhancement type field effect transistor	
N-channel MOS enhancement type field effect transistor (gate taken out of a substrate and connected to case)	
N-channel MOS depletion type field effect transistor	
N-channel MOS depletion type field effect transistor (gate taken out of a substrate)	
Dual-gate N-channel MOS depletion type field effect transistor (substrate internally connected to source)	
Twin transistor	
High-speed switching N-type base uni-junction transistor	

TECHNICAL DATA

2SA

SERIES

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

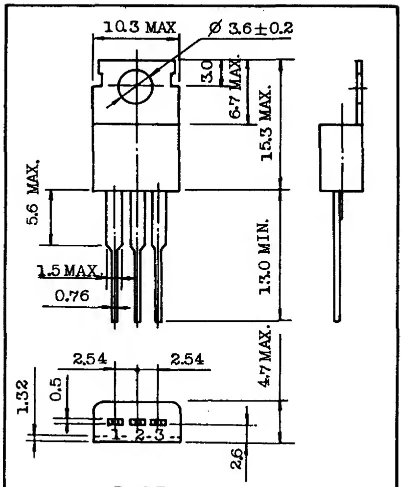
2SA473

POWER AMPLIFIER APPLICATIONS.
CAR RADIO AND CAR STEREO OUTPUT STAGE APPLICATIONS

FEATURES:

- Good Linearity of h_{FE}.
- Complementary to 2SC1173.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No.· AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

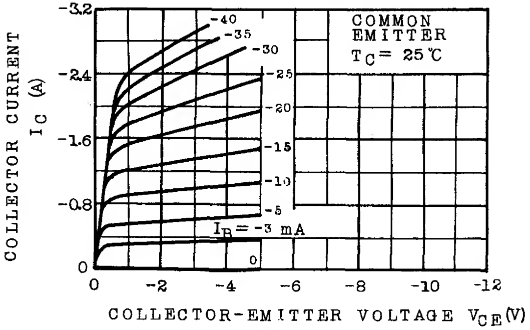
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-30	V
Collector-Emitter Voltage	V_{CEO}	-30	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Emitter Current	I_E	3	A
Collector Power Dissipation (Tc=25°C)	Pc	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

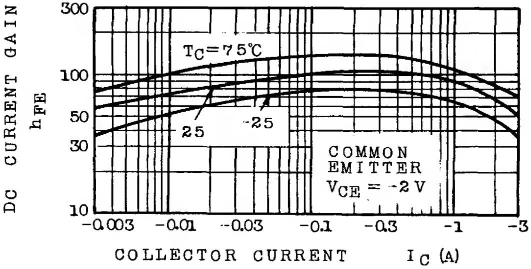
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-20V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-1mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=-2V, I_C=-0.5A	70	-	240	
	$h_{FE}(2)$	V_{CE}=-2V, I_C=-2.5A	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-2A, I_B=-0.2A	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-0.5A	-	-0.75	-1.0	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	40	-	pF

Note: $h_{FE}(1)$ Classification O : 70∿140, Y : 120∿240

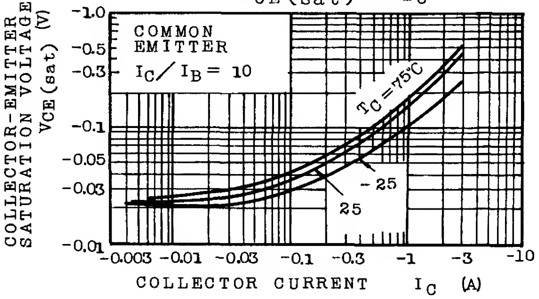
I_C — V_{CE}



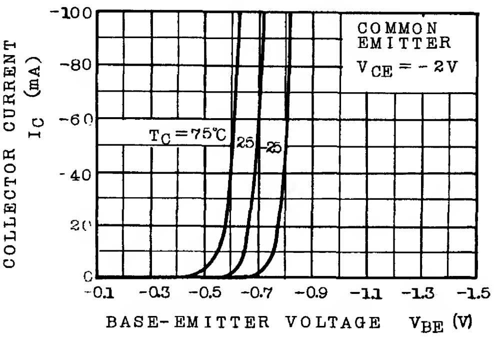
h_{FE} — I_C



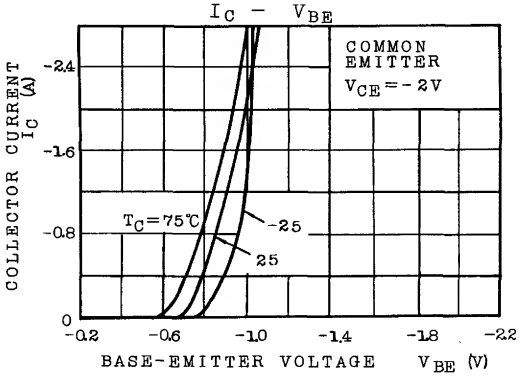
$V_{CE(sat)}$ — I_C



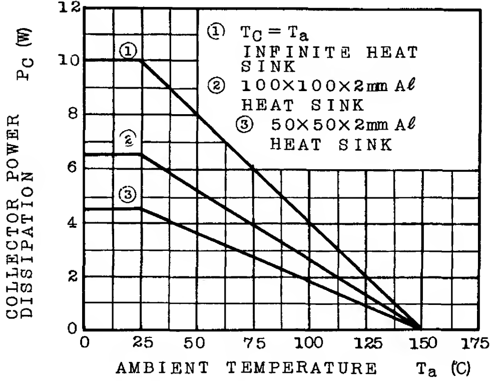
I_C — V_{BE}



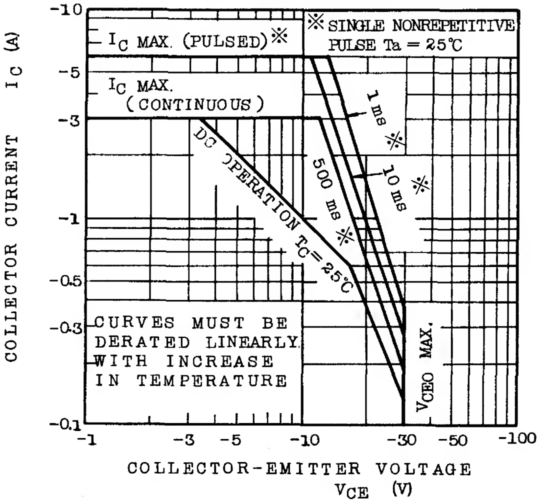
I_C — V_{BE}



P_C — T_a



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

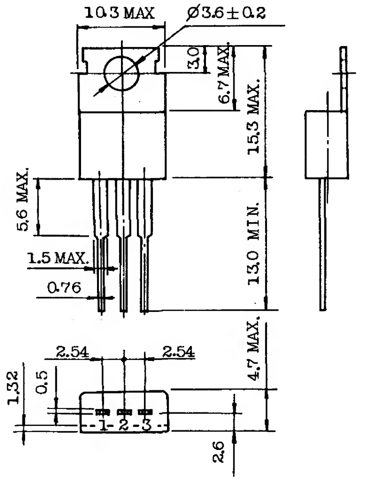
2SA490

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC790.
- 10 Watts Output Applications.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-50	V
Collector-Emitter Voltage	V_{CEO}	-40	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Emitter Current	I_E	3	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

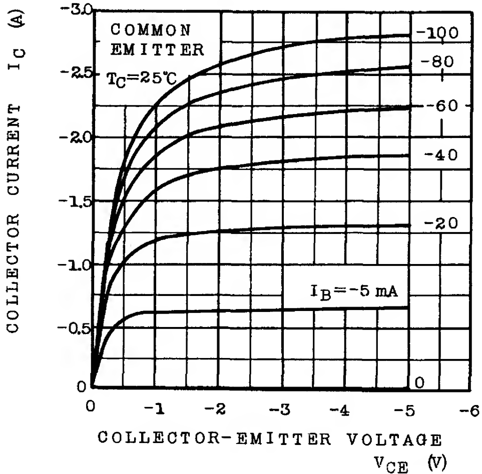
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-2V, I_C=-0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-2A	13	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-2A, I_B=-0.2A	-	-0.45	-1.2	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-2A	-	-0.85	-1.8	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	3	10	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	150	-	pF

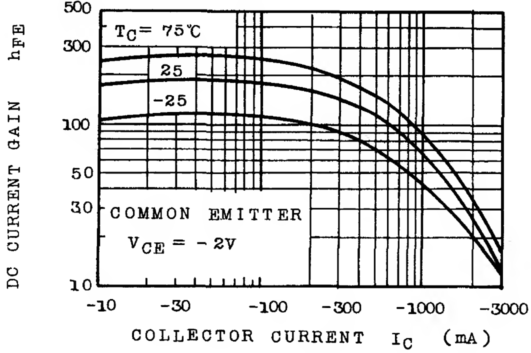
Note : $h_{FE(1)}$ Classification R : 40∿80 O : 70∿140 Y : 120∿240

2SA490

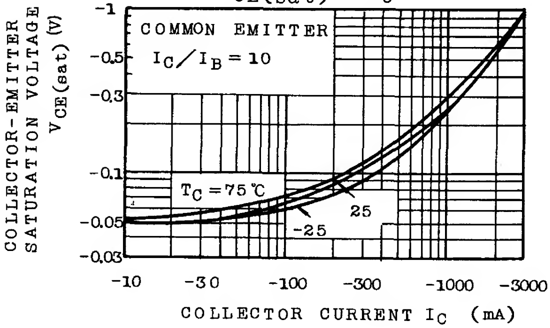
I_C – V_{CE}



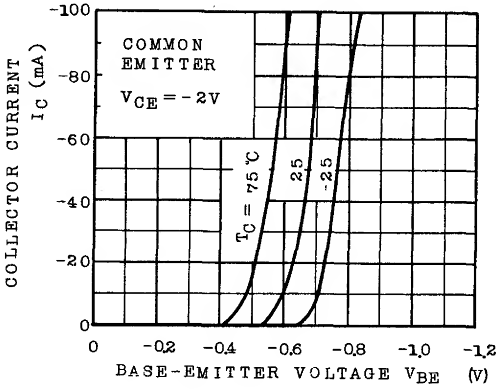
h_{FE} – I_C



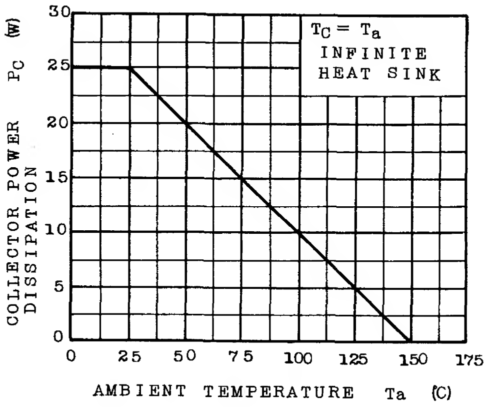
$V_{CE(sat)}$ – I_C



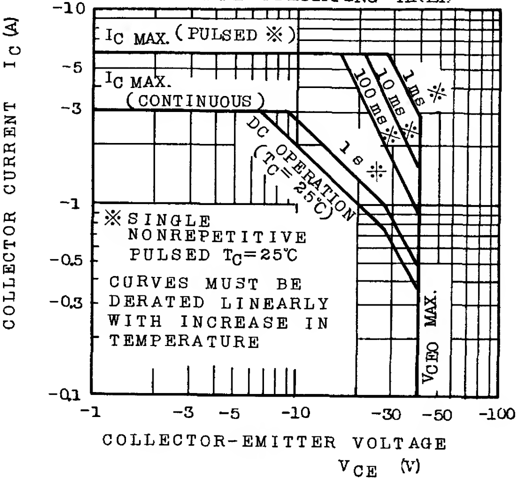
I_C – V_{BE}



P_C – T_a



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA496
2SA505

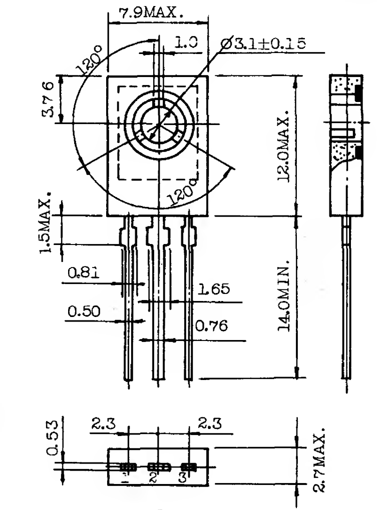
MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage

  : $V_{CE(sat)}$=-0.32V (Typ.)
- Complementary to 2SC495 and 2SC496.

Unit in mm



1. EMITTER
2. COLLECTOR(HEAT SINK)
3. BASE

JEDEC	TO — 126
EIAJ	—
TOSHIBA	2 — 8F1A

Mounting Kit No. AC46C
Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

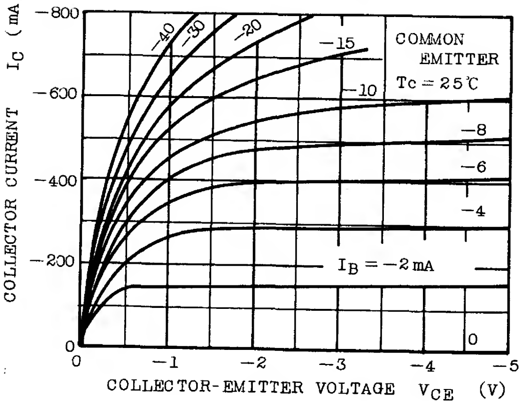
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA505	V_{CBO}	-60	V
	2SA496		-40	
Collector-Emitter Voltage	2SA505	V_{CEO}	-50	V
	2SA496		-30	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1	A
Emitter Current		I_E	1	A
Collector Power Dissipation		P_C	1	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

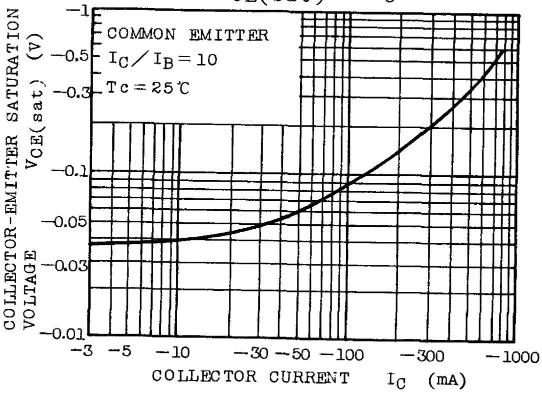
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	μA
Collector-Emitter Breakdown Voltage	2SA505	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-50	-	-	V
	2SA496			-30	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	-5	-	-	V
DC Current Gain		(Note) $h_{FE(1)}$	V_{CE}=-2V, I_C=-50mA	40	-	240	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-800mA	13	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-0.32	-0.8	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-2V, I_C=-500mA	-	-	-1.3	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-10mA	50	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	20	-	pF

Note: h_{FE}(1) Classification R : 40∿80 O : 70∿140 Y : 120∿240

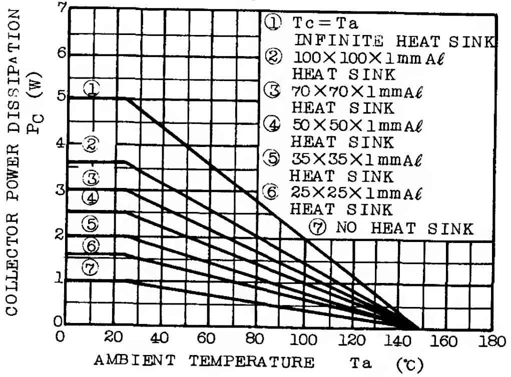
I_C – V_{CE}



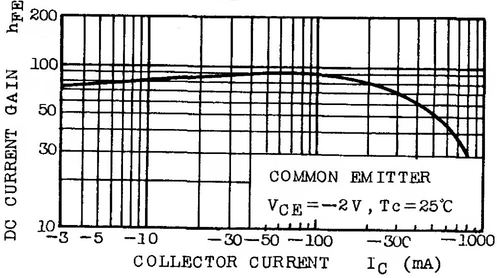
$V_{CE(sat)}$ – I_C



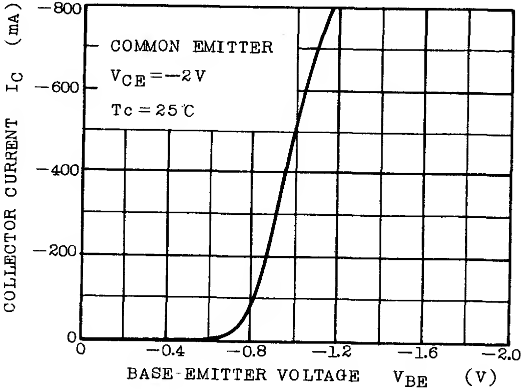
P_C – Ta



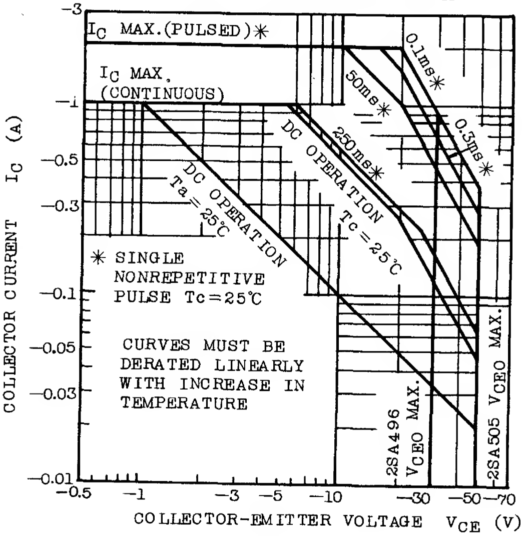
h_{FE} – I_C



I_C – V_{BE}



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA503
2SA504

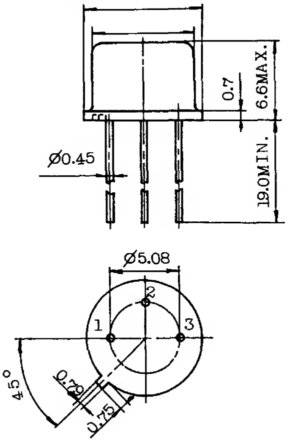
HIGH FREQUENCY AMPLIFIER APPLICATIONS.

HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=80MHz (Typ.)
- High Breakdown Voltage : V_{CEO}=-80V (2SA503)
  : V_{CEO}=-60V (2SA504)
- Low Saturation Voltage : $V_{CE(sat)}$=-0.12V (Typ.)
  (at I_C=-150mA, I_B=-15mA)
- Complementary to 2SC503 and 2SC504.

INDUSTRIAL APPLICATIONS
Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

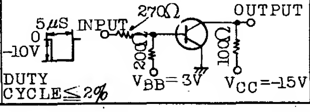
JEDEC	TO – 39
EIAJ	TC – 5, TB – 5B
TOSHIBA	2 – 8B1A

Weight : 1.13g

MAXIMUM RATINGS (Ta=25°C)

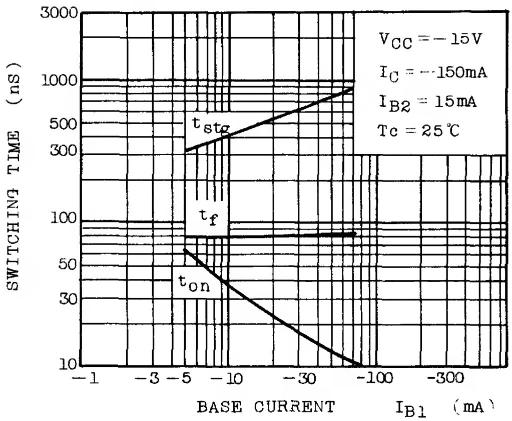
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA503	V_{CBO}	-100	V
	2SA504		-80	
Collector-Emitter Voltage	2SA503	V_{CEO}	-80	V
	2SA504		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-600	mA
Base Current		I_B	-100	mA
Collector Power Dissipation	Ta=25°C	P_C	800	mW
	Tc=25°C		6	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

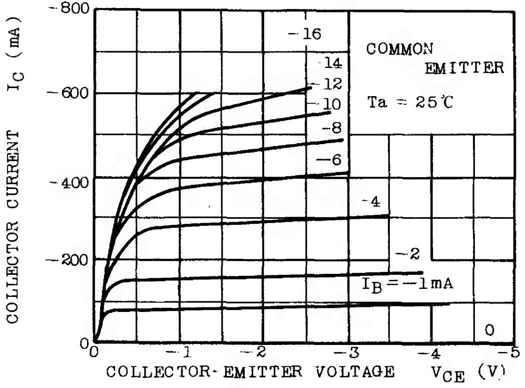
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SA503	I_{CBO}	V_{CB}=-80V, I_E=0	-	-	-0.5	μA
	2SA504		V_{CB}=-60V, I_E=0				
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
DC Current Gain		h_{FE} (Note)	V_{CE}=-2V, I_C=-150mA	30	-	300	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-150mA, I_B=-15mA	-	-0.12	-0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-150mA, I_B=-15mA	-	-0.8	-1.5	V
Transition Frequency		f_T	V_{CE}=-2V, I_C=-150mA	50	80	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	22	30	pF
Base Intrinsic Resistance		$r_{bb'}$	V_{CE}=-10V, I_E=1mA, f=30MHz	-	12	30	Ω
Switching Time	Turn-on Time	t_{on}		-	60	-	ns
	Storage Time	t_{stg}		-	450	-	
	Fall Time	t_f		-	80	-	

Note : h_{FE} Classification O : 30∿90, Y : 50∿150, GR : 100∿300

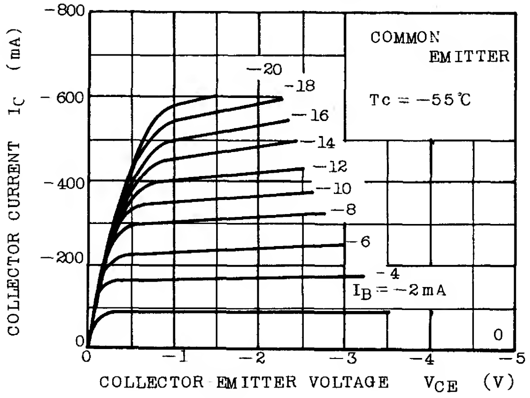
SWITCHING CHARACTERISTICS



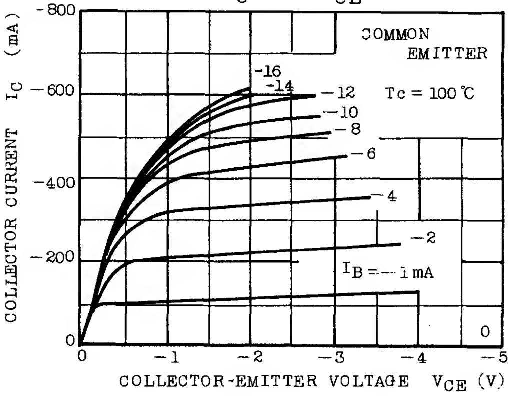
IC − VCE



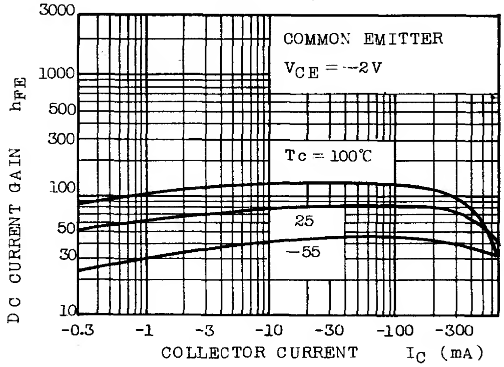
IC − VCE



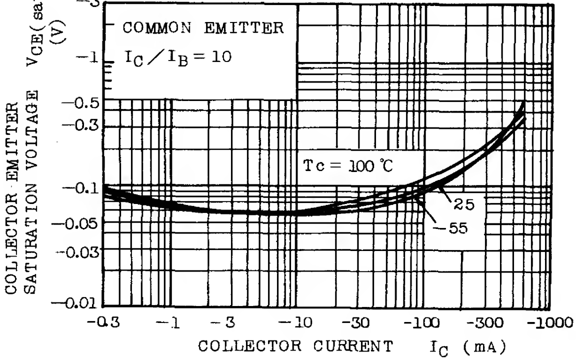
IC − VCE

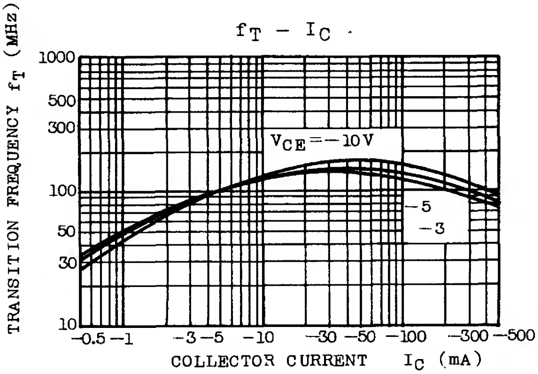


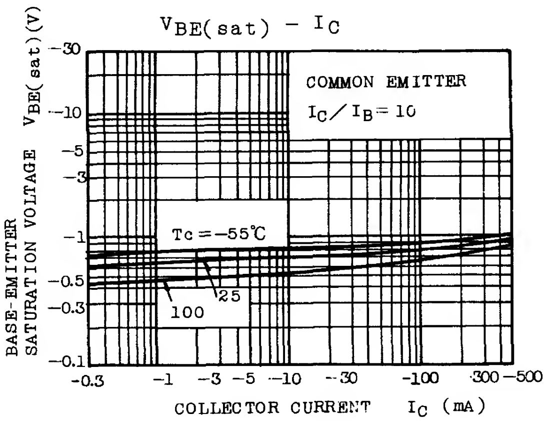
hFE − IC

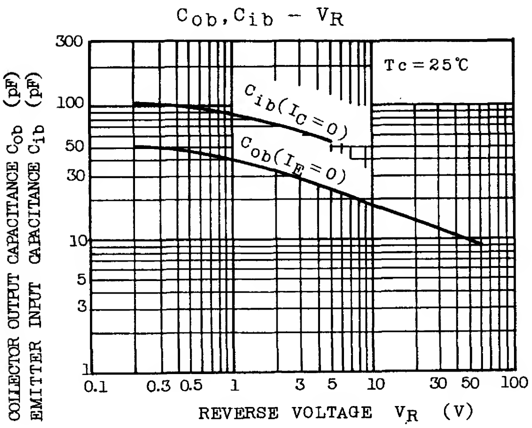


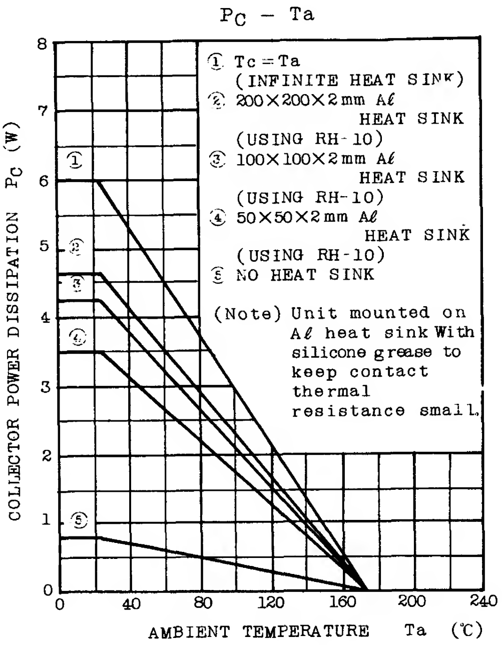
VCE(sat) − IC




fT – IC
TRANSITION FREQUENCY fT (MHz)
1000
500
300
100
50
30
10
VCE=−10V
−5
−3
−0.5 −1 −3 −5 −10 −30 −50 −100 −300 −500
COLLECTOR CURRENT IC (mA)


VBE(sat) – IC
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
−30
−10
−5
−3
−1
−0.5
−0.3
−0.1
COMMON EMITTER
IC/IB=10
Tc=−55℃
25
100
−0.3 −1 −3 −5 −10 −30 −100 −300 −500
COLLECTOR CURRENT IC (mA)


Cob, Cib – VR
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
EMITTER INPUT CAPACITANCE Cib (pF)
300
100
50
30
10
5
3
1
Tc=25℃
Cib(IC=0)
Cob(IE=0)
0.1 0.3 0.5 1 3 5 10 30 50 100
REVERSE VOLTAGE VR (V)


PC – Ta
COLLECTOR POWER DISSIPATION PC (W)
8
7
6
5
4
3
2
1
0
① Tc=Ta (INFINITE HEAT SINK)
② 200×200×2mm Aℓ HEAT SINK (USING RH-10)
③ 100×100×2mm Aℓ HEAT SINK (USING RH-10)
④ 50×50×2mm Aℓ HEAT SINK (USING RH-10)
⑤ NO HEAT SINK
(Note) Unit mounted on Aℓ heat sink With silicone grease to keep contact thermal resistance small.
①
②
③
④
⑤
0 40 80 120 160 200 240
AMBIENT TEMPERATURE Ta (℃)

2SA510
2SA512

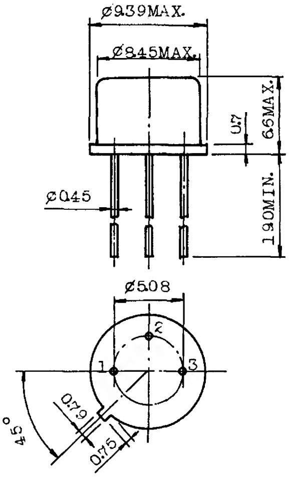
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

INDUSTRIAL APPLICATIONS
Unit in mm

HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=-100V (2SA510)
  : V_{CEO}=-60V (2SA512)
- Various Uses for Medium Power
  : I_C=-1.5A (Max.), P_C=800mW (Max.)
- Complementary to 2SC510 and 2SC512.



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

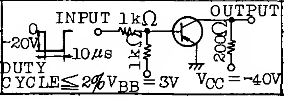
JEDEC	TO-39
EIAJ	TC-5,TB-5B
TOSHIBA	2-8B1A

Weight : 1.13g

MAXIMUM RATINGS (Ta=25°C)

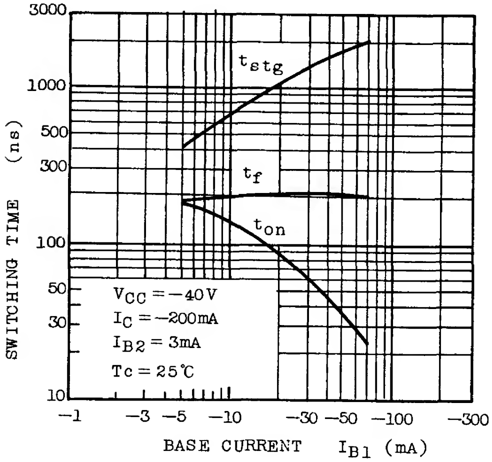
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA510	V_{CBO}	-120	V
	2SA512		-80	
Collector-Emitter Voltage	2SA510	V_{CEO}	-100	V
	2SA512		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-300	mA
Collector Power Dissipation	Ta=25°C	P_C	800	mW
	Tc=25°C		8	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		Tstg	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

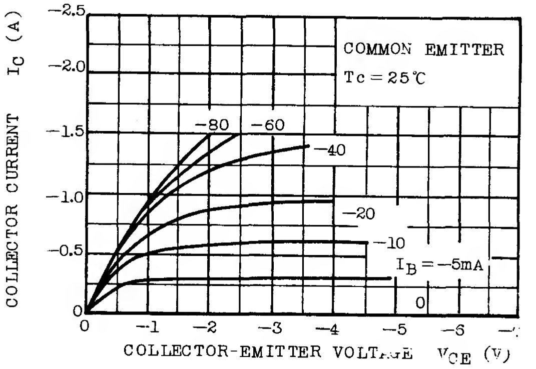
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	μA
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-2V, I_C=-200mA	30	-	150	
		$h_{FE(2)}$	V_{CE}=-5V, I_C=-1A	15	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-200mA, I_B=-20mA	-	-0.3	-0.6	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-200mA, I_B=-20mA	-	-0.85	-1.0	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-30mA	20	60	-	MHz
Collector Output Capacitance		Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	43	50	pF
Switching Time	Turn-on Time	t_{on}	 INPUT 1kΩ OUTPUT 0 -20V 10μs 1kΩ 200Ω DUTY CYCLE≦2% V_{BB}=3V V_{CC}=-40V	-	0.12	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.2	-	

Note : $h_{FE(1)}$ Classification R : 30∿90, 0 : 50∿150

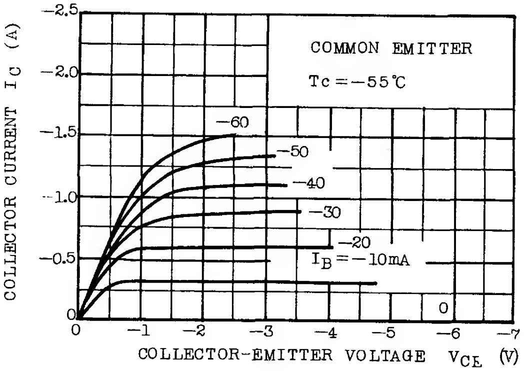
SWITCHING CHARACTERISTICS



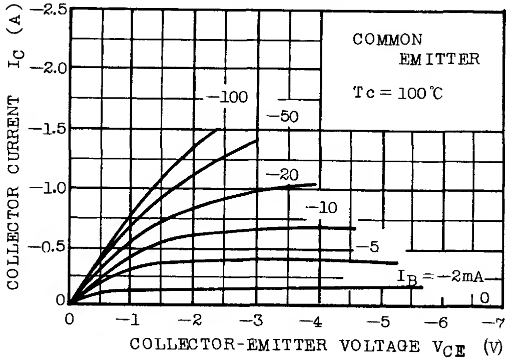
$I_C - V_{CE}$



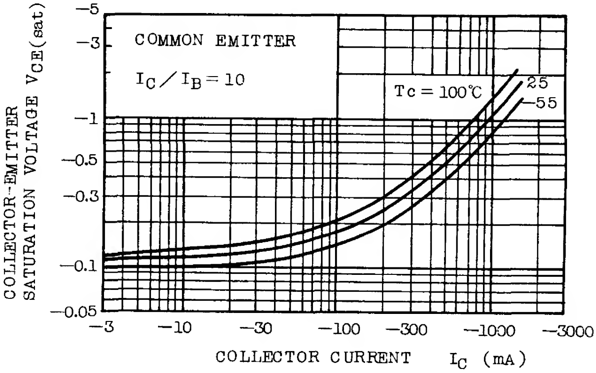
$I_C - V_{CE}$



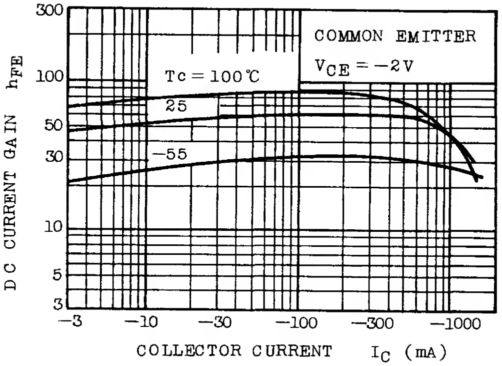
$I_C - V_{CE}$

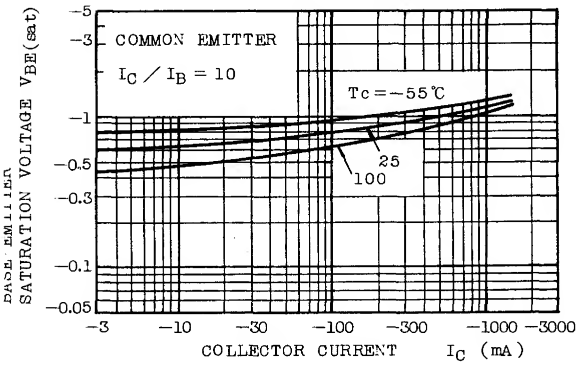


$V_{CE(sat)} - I_C$

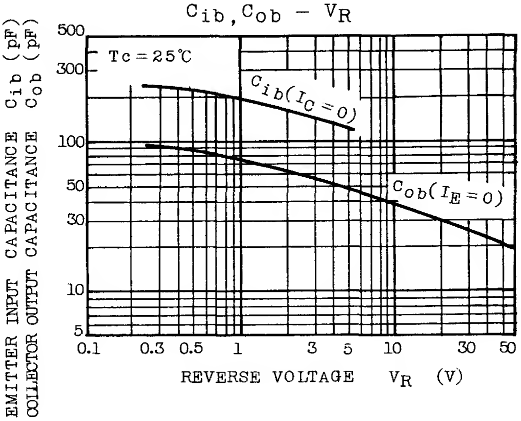


$h_{FE} - I_C$

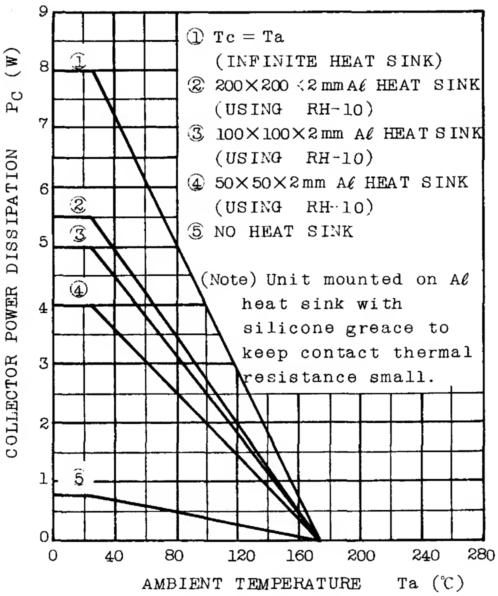




$V_{BE(sat)}$ − I_C



C_{ib}, C_{ob} − V_R



P_C − Ta

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

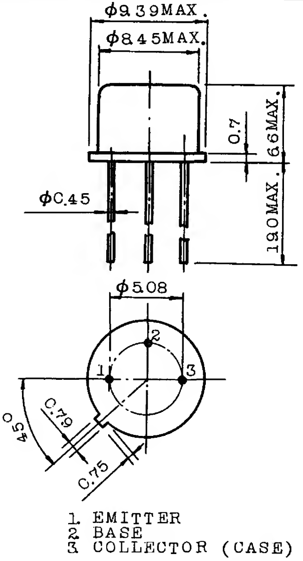
2SA594

HIGH FREQUENCY AMPLIFIER APPLICATIONS

VIDEO AMPLIFIER APPLICATIONS.

HIGH SPEED SWITCHING APPLICATIONS.

Unit in mm



JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1A

Weight : 1.13g

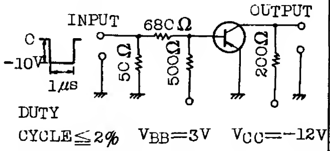
FEATURES:

- High Transition Frequency; f_T = 200MHz (TYP.)
- Low Output Capacitance; C_{ob} = 3.5pF (Typ.)
- Low Saturation Voltage; $V_{CE(sat)}$ = -0.3V (Max.)
  at I_C = -100mA , I_B = -10mA
- Complementary to 2SC594

MAXIMUM RATINGS (Ta=25°C)

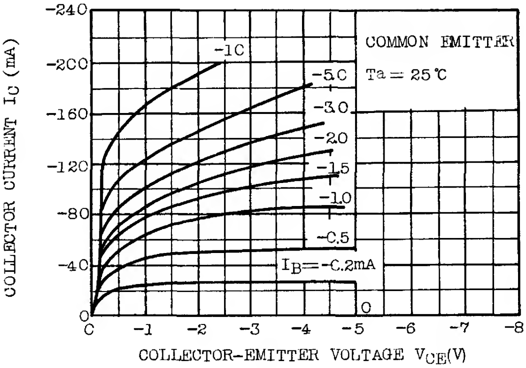
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-45	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-200	mA
Base Current		I_B	-50	mA
Collector Power Dissipation	Ta=25°C	P_C	750	mW
	Tc=25°C		5	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

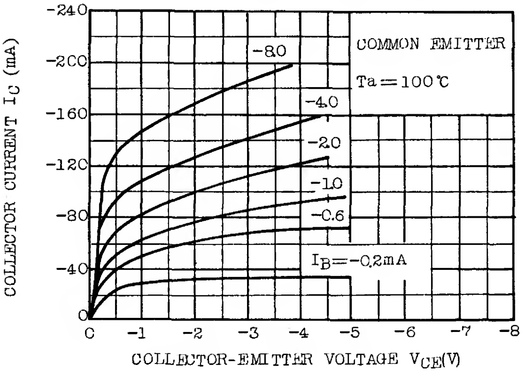
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-45V, I_E=0	-	-	-0.1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-0.1	μA
DC Current Gain		$h_{FE(1)}$ (Note.)	V_{CE}=-1V, I_C=-10mA	40	-	240	
		$h_{FE(2)}$	V_{CE}=-3V, I_C=-200mA	20	-	-	
Collector-Emitter Saturation voltage		$V_{CE(sat)}$	I_C=-100mA, I_B=-10mA	-	-	-0.3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-100mA, I_B=-10mA	-	-	-1.0	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-10mA	100	200	-	MHz
Input Resistance		h_{ie}	V_{CE}=-10V, I_E=10mA, f=200MHz	-	-	120	Ω
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	3.5	5	PF
Switching Time	Turn-On Time	t_{on}	 INPUT OUTPUT 0 -10V 1μs 680Ω 50Ω 500Ω 200Ω DUTY CYCLE≦2% VBB=3V VCC=-12V	-	40	-	ns
	Storage Time	t_{stg}		-	250	-	
	Fall Time	t_f		-	30	-	

Note ; $h_{FE(1)}$ Classification R : 40 ~ 80, 0 : 70 ~ 140, Y : 120 ~ 240

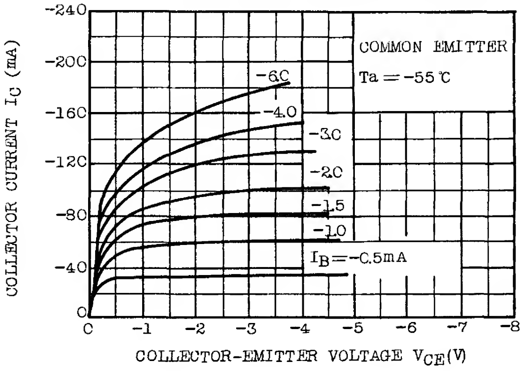
I_C - V_{CE} (LOW VOLTAGE REGION)



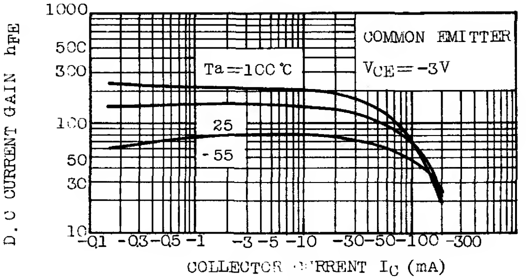
I_C - V_{CE} (LOW VOLTAGE REGION)



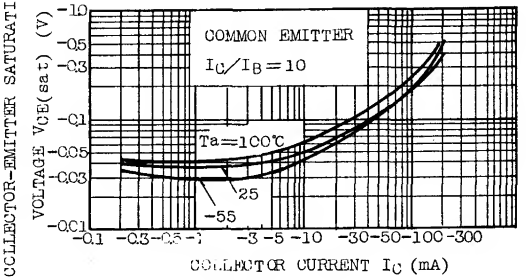
I_C - V_{CE} (LOW VOLTAGE REGION)



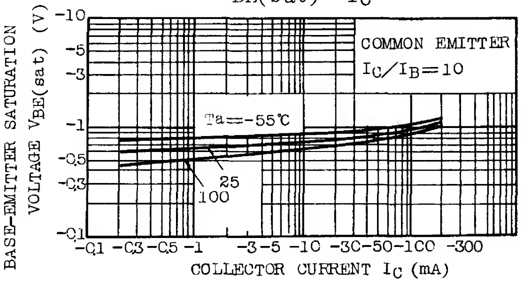
h_{FE} - I_C



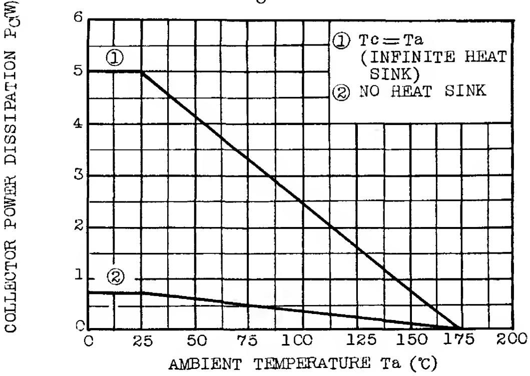
$V_{CE(sat)}$ - I_C



$V_{BE(sat)}$ - I_C



P_C - Ta



SILICON PNP TRIPLE DIFFUSED MAS TYPE

2SA656A
2SA657A
2SA658A

INDUSTRIAL APPLICATIONS

Unit in mm

POWER AMPLIFIER APPLICATIONS.

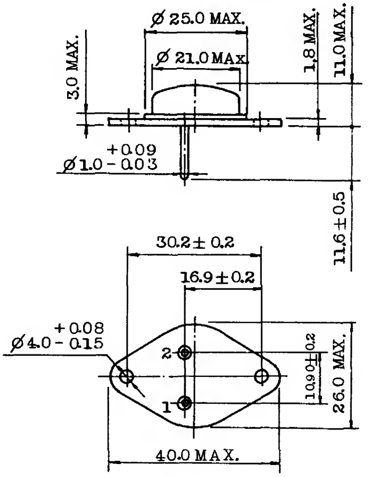
POWER SWITCHING APPLICATIONS.

DC-DC CONVERTER APPLICATIONS.

REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=-130V, V_{CEO}=-110V (2SA656A)
- Complementary to 2SC519A, 2SC520A and 2SC521A.



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21A1A

Mounting Kit No. AC73

Weight : 12g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA656A	V_{CBO}	-130	V
	2SA657A		-100	
	2SA658A		-70	
Collector-Emitter Voltage	2SA656A	V_{CEO}	-110	V
	2SA657A		-80	
	2SA658A		-50	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-2	A
Collector Power Dissipation	Tc=25°C	P_C	50	W
	(Note)		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65 ∿ 150	°C

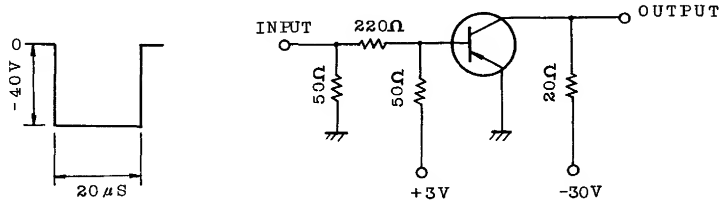
Note : Unit mounted a 300x300x2mm Al on a heat sink with silicone greased mica insulator.

2SA656A・2SA657A・2SA658A

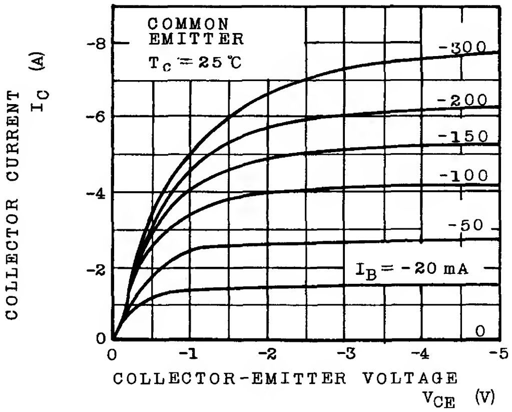
ELECTRICAL CHARACTERISITICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SA656A	I_{CBO}	V_{CB}=-130V, I_E=0	-	-	-100	μA
	2SA657A		V_{CB}=-100V, I_E=0	-	-	-100	
	2SA658A		V_{CB}=-70V, I_E=0	-	-	-100	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5	mA
Collector-Emitter Breakdown Voltage	2SA656A	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-110	-	-	V
	2SA657A			-80	-	-	
	2SA658A			-50	-	-	
DC Current Gain		$h_{FE}(1)$	V_{CE}=-5V, I_C=-1A	30	-	300	
		$h_{FE}(2)$	V_{CE}=-5V, I_C=-5A	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-5A, I_B=-1A	-	-0.7	-2	V
	Base-Emitter	$V_{BE(sat)}$		-	-1.4	-2.5	
Transition Frequency		f_T	V_{CE}=-10V, I_C=-1A	-	5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-50V, I_E=0, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	(Fig.)	-	0.5	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.4	-	

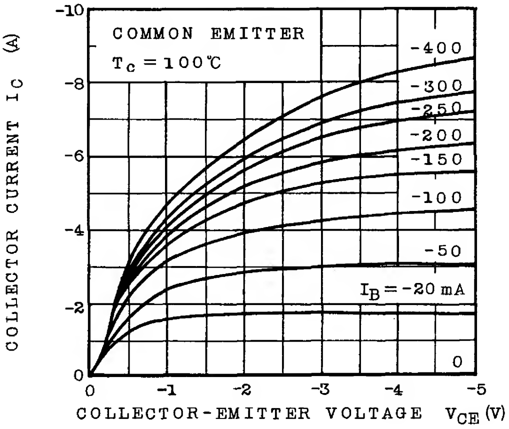
Fig. SWITCHING TIME TEST CIRCUIT



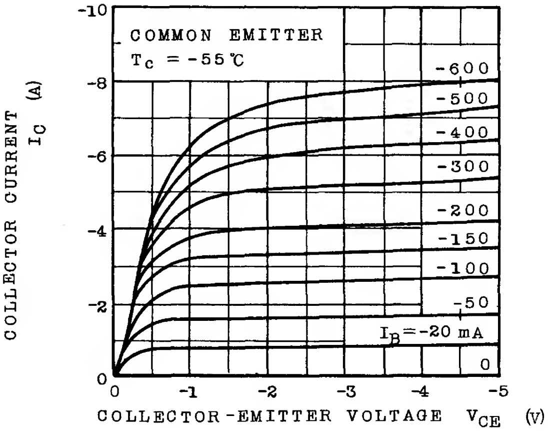
DUTY CYCLE ≦ 2%



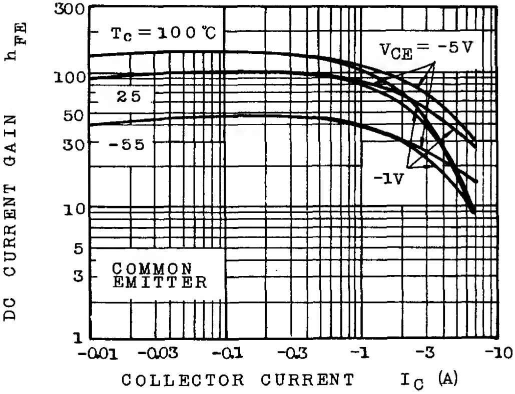
$I_C - V_{CE}$



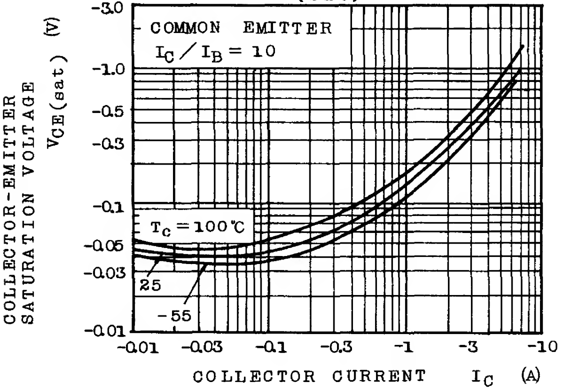
$I_C - V_{CE}$



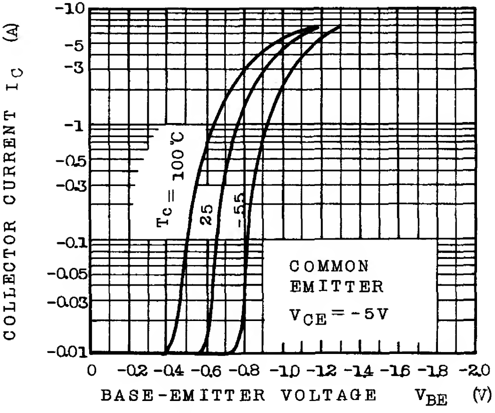
$I_C - V_{CE}$



$h_{FE} - I_C$



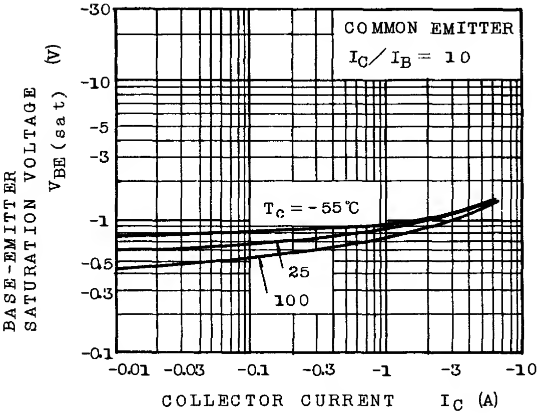
$V_{CE(sat)} - I_C$



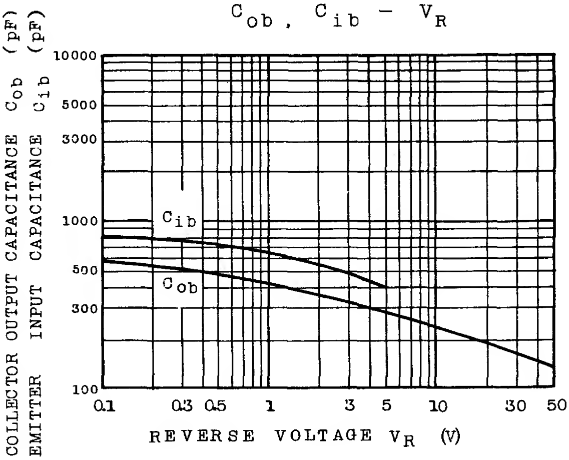
$I_C - V_{BE}$

2SA656A・2SA657A・2SA658A

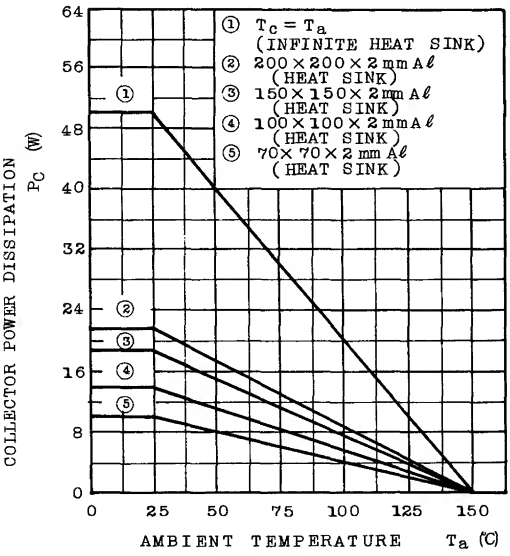
$V_{BE(sat)}$ − I_C



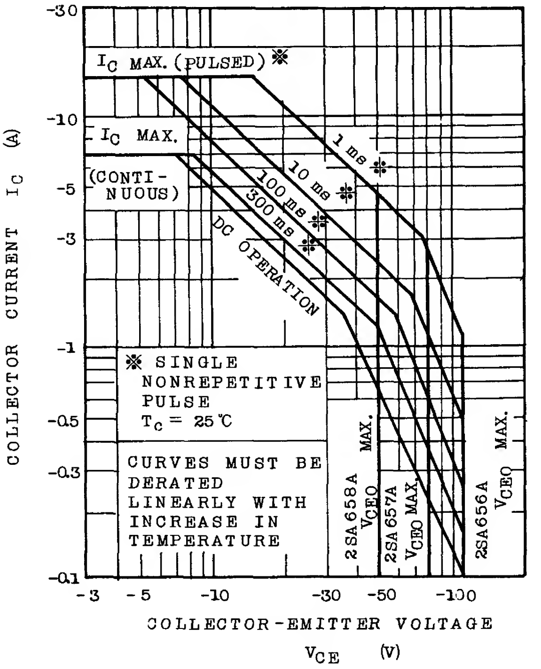
C_{ob} , C_{ib} − V_R



P_C − T_a



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED MESA TYPE

2SA739

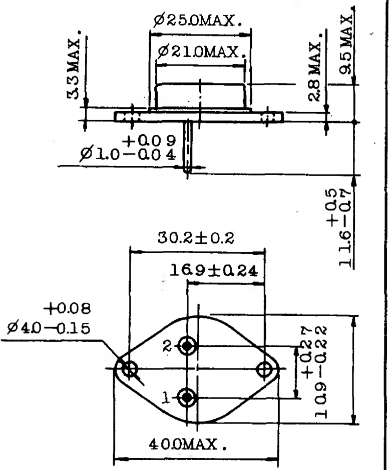
INDUSTRIAL APPLICATIONS

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=-400V
- Low Saturation Voltage : $V_{CE(sat)}$=-1.5V (Max.)
  (I_C=-1A, I_B=-0.2A)

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

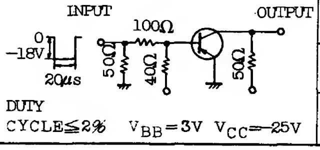
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

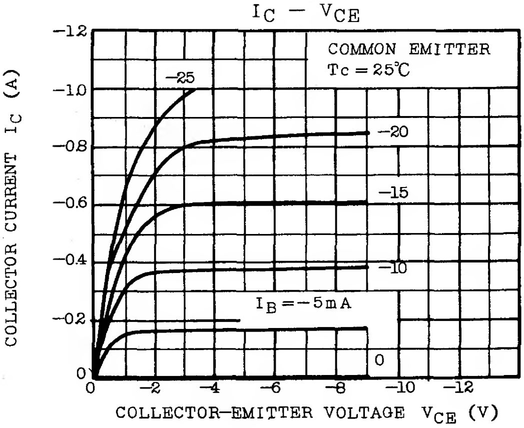
Mounting Kit No. AC73
Weight : 15.8g

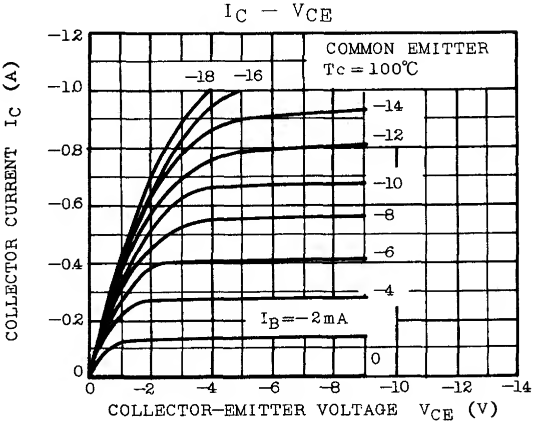
MAXIMUM RATINGS (Ta=25°C)

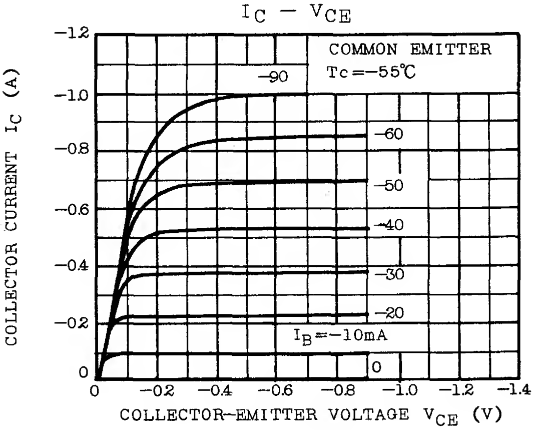
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-400	V
Collector-Emitter Voltage	V_{CEO}	-400	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

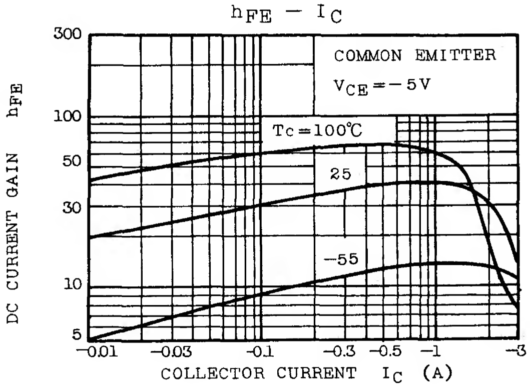
ELECTRICAL CHARACTERISTICS (Ta=25°C)

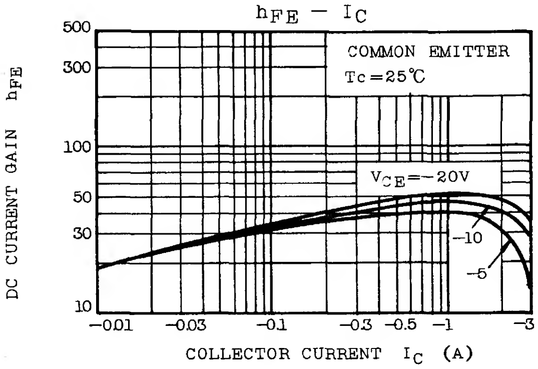
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-300V, I_E=0	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=-5V, I_C=-0.5A	20	-	300	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-1A, I_B=-0.2A	-	-	-1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-1A, I_B=-0.2A	-	-	-2.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=-50V, I_E=0, f=1MHz	-	100	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT 100Ω 0 −18V 20μs 50Ω 40Ω 50Ω DUTY CYCLE≦2% V_{BB}=3V V_{CC}=−25V	-	1.0	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	1.0	-	

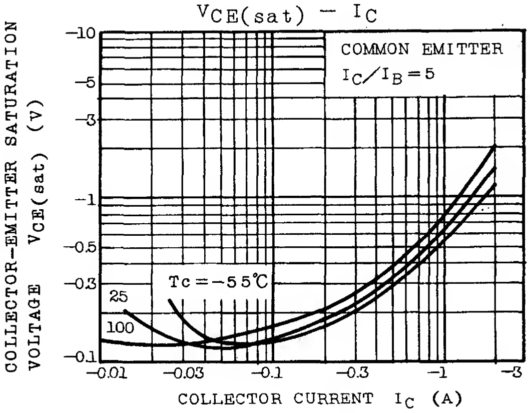

$I_C - V_{CE}$
COMMON EMITTER
Tc = 25℃
COLLECTOR CURRENT I_C (A)
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
0
−25
−20
−15
−10
I_B = −5mA
0
0
−2
−4
−6
−8
−10
−12
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)


$I_C - V_{CE}$
COMMON EMITTER
Tc = 100℃
COLLECTOR CURRENT I_C (A)
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
0
−18
−16
−14
−12
−10
−8
−6
−4
I_B = −2mA
0
0
−2
−4
−6
−8
−10
−12
−14
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

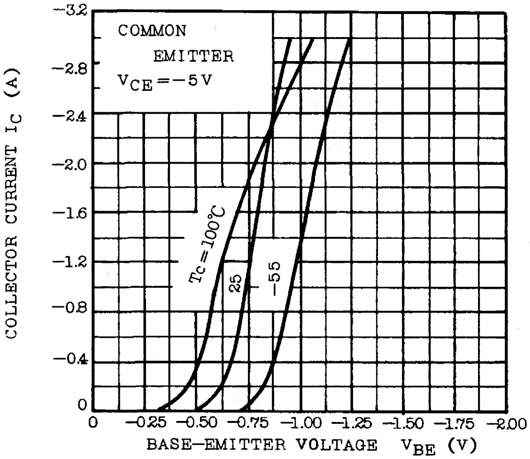

$I_C - V_{CE}$
COMMON EMITTER
Tc = −55℃
COLLECTOR CURRENT I_C (A)
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
0
−90
−60
−50
−40
−30
−20
I_B = −10mA
0
0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)


$h_{FE} - I_C$
COMMON EMITTER
V_{CE} = −5V
DC CURRENT GAIN h_{FE}
300
100
50
30
10
5
Tc = 100℃
25
−55
−0.01
−0.03
−0.1
−0.3
−0.5
−1
−3
COLLECTOR CURRENT I_C (A)

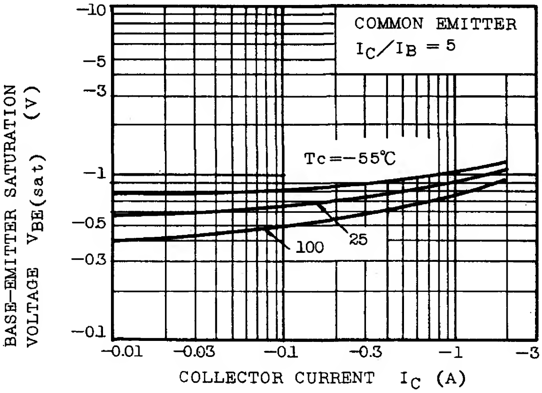

$h_{FE} - I_C$
COMMON EMITTER
Tc = 25℃
DC CURRENT GAIN h_{FE}
500
300
100
50
30
10
V_{CE} = −20V
−10
−5
−0.01
−0.03
−0.1
−0.3
−0.5
−1
−3
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B = 5
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−10
−5
−3
−1
−0.5
−0.3
−0.1
Tc = −55℃
25
100
−0.01
−0.03
−0.1
−0.3
−1
−3
COLLECTOR CURRENT I_C (A)

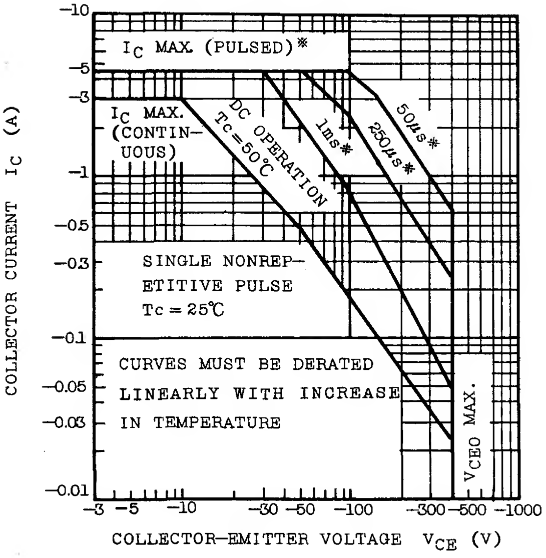
$I_C - V_{BE}$



$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



2SA814
2SA815

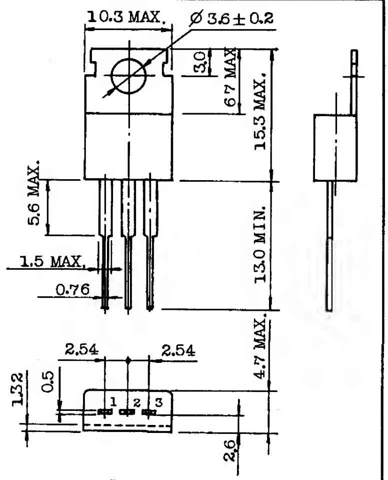
SILICON PNP EPITAXIAL BASE MESA TYPE

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage: V_{CEO}=-120V (2SA814)
  : V_{CEO}=-100V (2SA815)
- Complementary to 2SC1624 and 2SC1625.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No.: AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

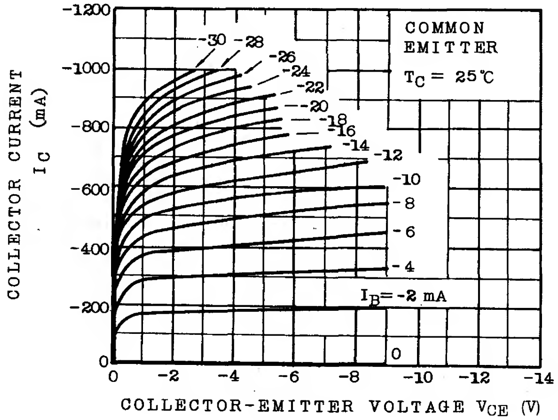
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA814	V_{CBO}	-120	V
	2SA815		-100	
Collector-Emitter Voltage	2SA814	V_{CEO}	-120	V
	2SA815		-100	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1	A
Emitter Current		I_E	1	A
Collector Power Dissipation	(Tc=25 °C)	P_C	15	W
Junction Temperature		Tj	150	°C
Storage Temperature Range		Tstg	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

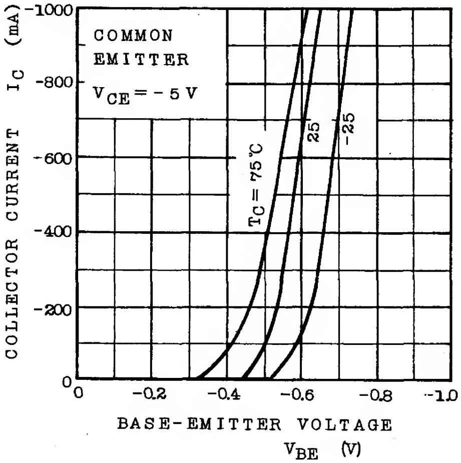
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-50V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	2SA814	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-120	-	-	V
	2SA815			-100	-	-	
Emitter-Base Breakdown Voltage		$V_{(BE)EBO}$	I_E=-1mA, I_C=0	-5	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-150mA	70	-	240	
		$h_{FE(2)}$	V_{CE}=-5V, I_C=-500mA	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-0.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-5V, I_C=-500mA	-	-	-1.0	V
Transition Frequency		f_T	V_{CE}=-5V, I_C=-150mA	10	30	-	MHz
Collector Output Capacitance		Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF

Note: $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

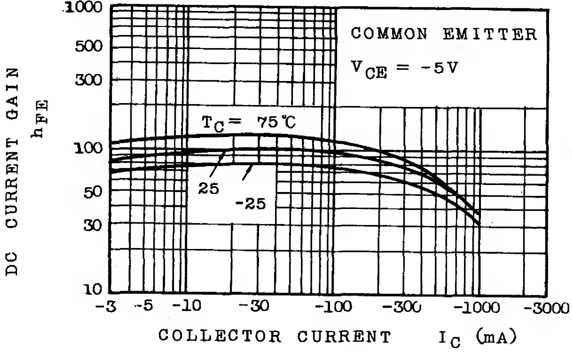
I_C − V_{CE}



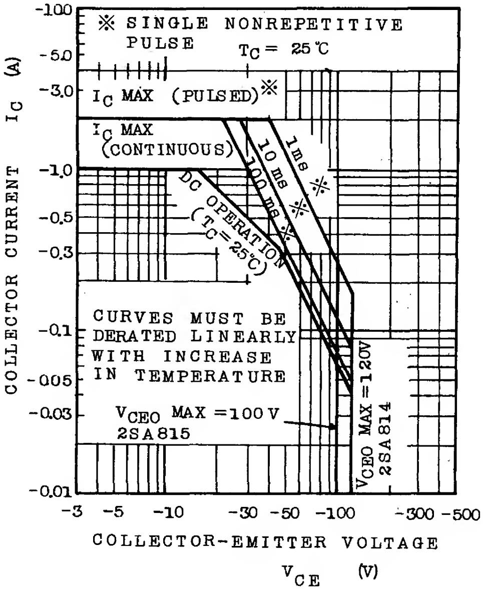
I_C − V_{BE}



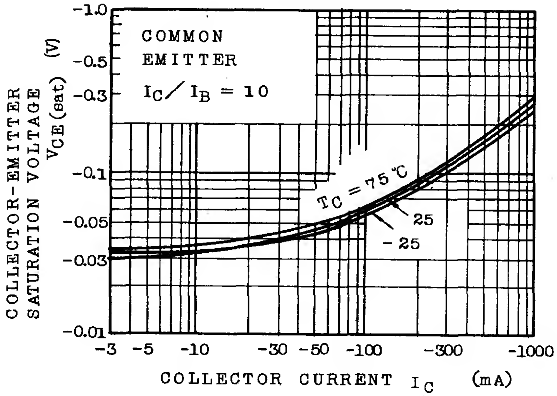
h_{FE} − I_C



SAFE OPERATING AREA



$V_{CE\,(sat)}$ − I_C



2SA816

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

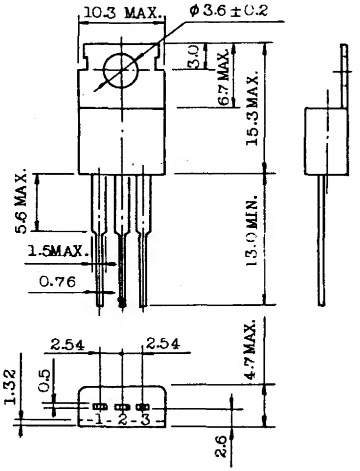
FEATURES:

- High Breakdown Voltage : V_{CEO}=-80V
- Complementary to 2SC1626.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-750	mA
Emitter Current	I_E	750	mA
Collector Power Dissipation (Ta=25°C)	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿ 150	°C

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-0.5	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-0.1mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=-2V, I_C=-150mA	70	-	240	
	$h_{FE}(2)$	V_{CE}=-2V, I_C=-500mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-0.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-500mA	-	-	-1.0	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-150mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	20	-	pF

Note : $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

2SA940

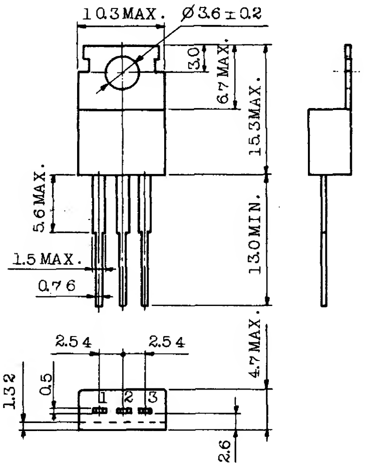
POWER AMPLIFIER APPLICATIONS.

VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- Complementary to 2SC2073

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Weight : 1.9g

Mounting kit No. AC75

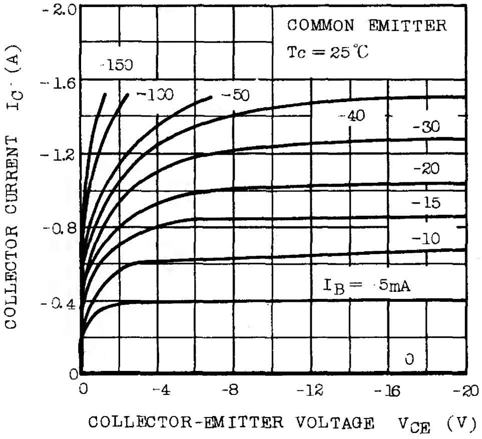
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-150	V
Collector-Emitter Voltage		V_{CEO}	-150	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

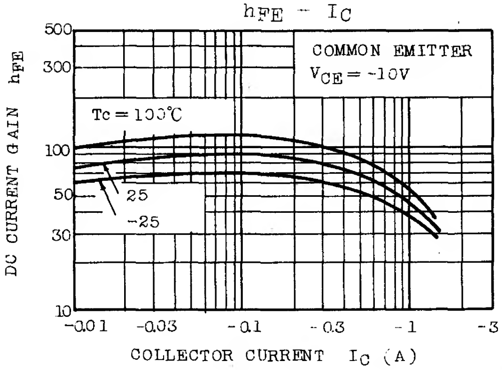
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-120V, I_E=0	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
DC Current Gain	h_{FE}	V_{CE}=-10V, I_C=-500mA	40	75	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-10V, I_C=-500mA	-0.65	-0.75	-0.85	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-500mA	-	4	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	55	-	pF

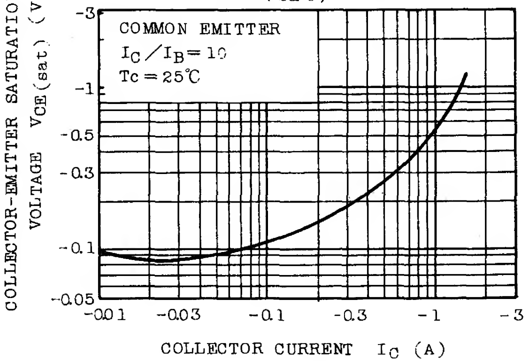
IC - VCE



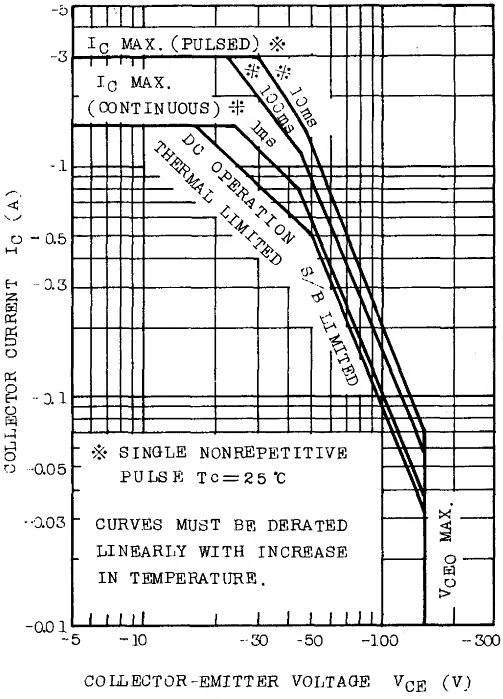
hFE - IC



VCE(sat) - IC



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

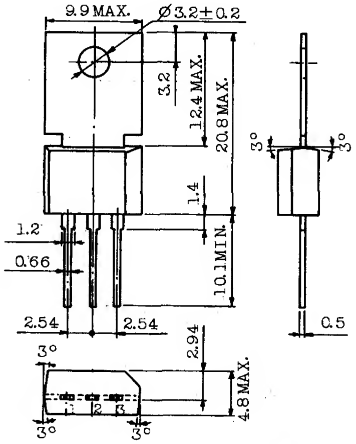
2SA962A

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Suitable for TV Sound Output, Vert. Deflection Output.
- Designed for Complementary Use with 2SC2194A.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR
   Collector Connected to Tab.

JEDEC	TO-202
EIAJ	–
TOSHIBA	2-10F1A

Weight : 1.37g

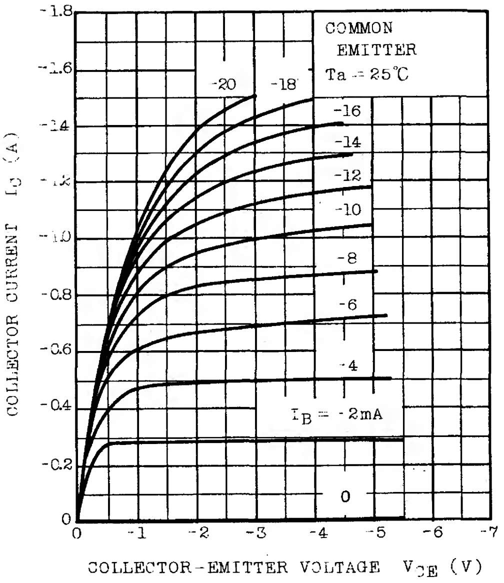
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

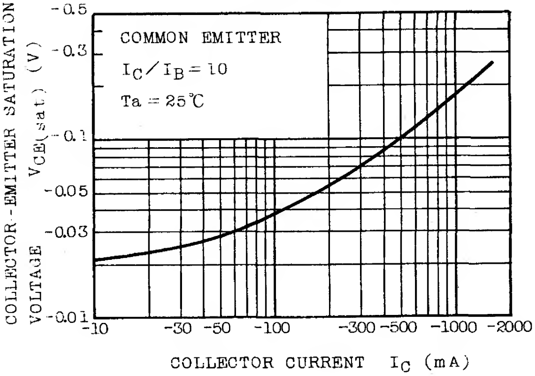
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CE}=-50V, I_E=0	–	–	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	–	–	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-50	–	–	V
DC Current Gain	h_{FE}	V_{CE}=-2V, I_C=-150mA	70	–	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-1A, I_B=-0.1A	–	–	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-10V, I_C=-10mA	-0.50	-0.60	-0.70	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-100mA	50	100	–	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	–	30	–	pF

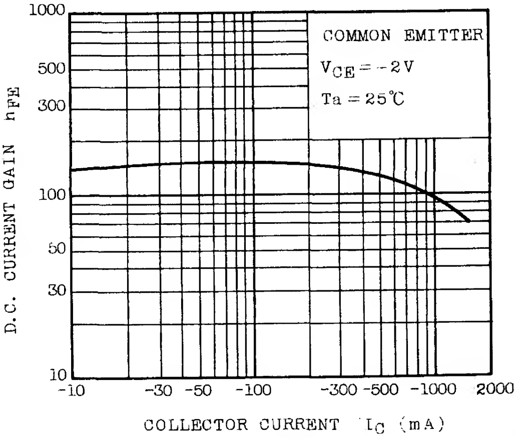
I_C - V_{CE}



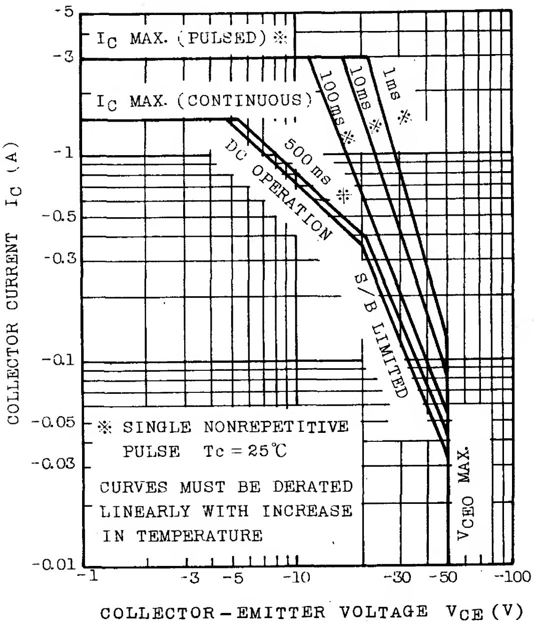
$V_{CE(sat)}$ - I_C



h_{FE} - I_C



SAFE OPERATING AREA



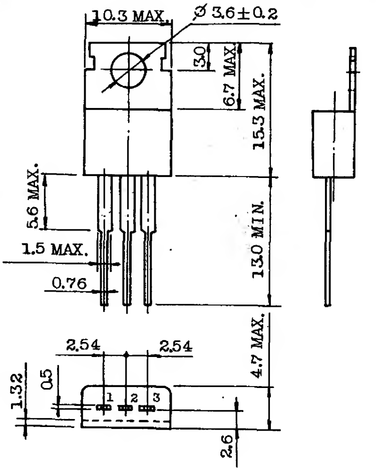
2SA968
2SA968A
2SA968B

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency: f_T=100MHz (Typ.)
- Complementary to 2SC2238, 2SC2238A, and 2SC2238B

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA968	V_{CBO}	-160	V
	2SA968A		-180	
	2SA968B		-200	
Collector-Emitter Voltage	2SA968	V_{CEO}	-160	V
	2SA968A		-180	
	2SA968B		-200	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1.5	A
Emitter Current		I_E	1.5	A
Collector Power Dissipation	(Tc=25°C)	P_C	25	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

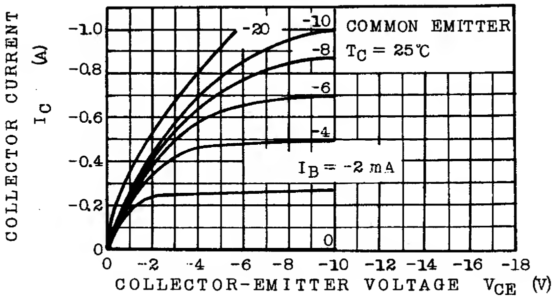
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-160V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	2SA968	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-160	-	-	V
	2SA968A			-180	-	-	
	2SA968B			-200	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=-1mA, I_C=0	-5	-	-	V
DC Current Gain		h_{FE} (Note)	V_{CE}=-5V, I_C=-100mA	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-5V, I_C=-500mA	-	-	-1.0	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-100mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF

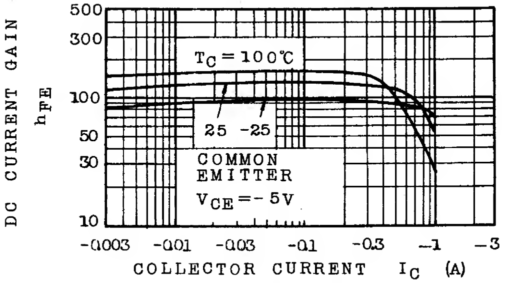
Note: h_{FE} Classification O: 70∿140, Y: 120∿240

2SA968・2SA968A・2SA968B

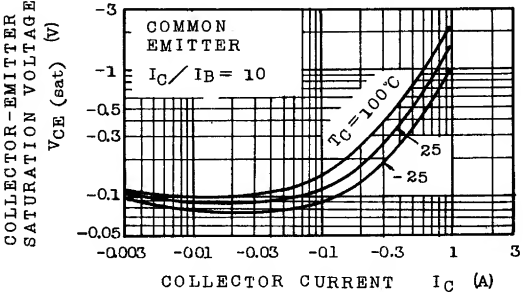
I_C – V_{CE}



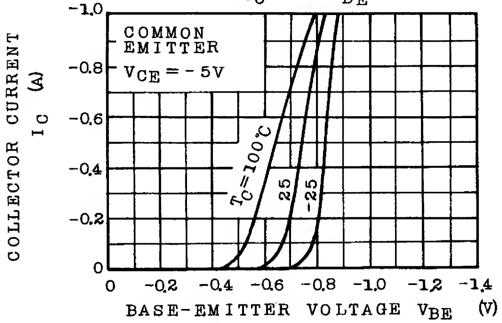
h_{FE} – I_C



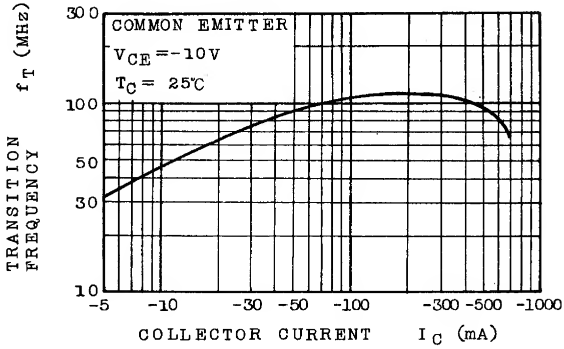
$V_{CE (sat)}$ – I_C



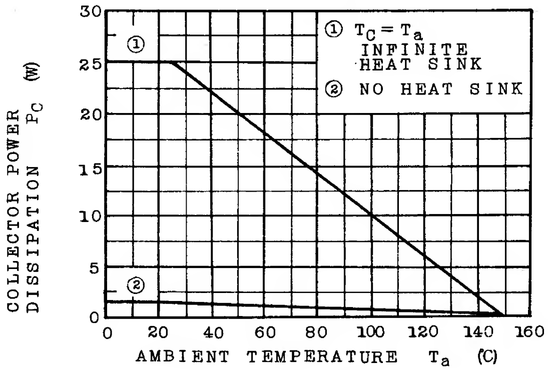
I_C – V_{BE}



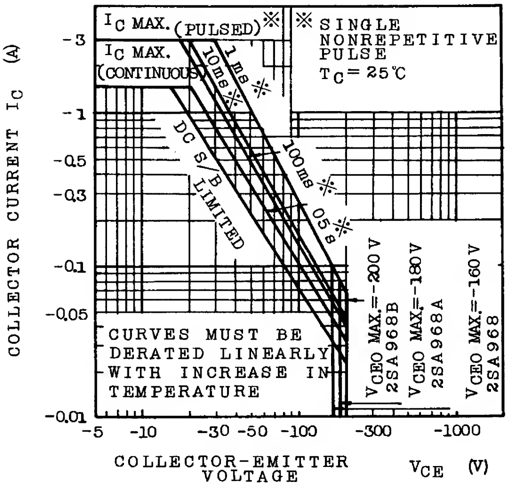
f_T – I_C



P_C – T_a



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1012

INDUSTRIAL APPLICATIONS

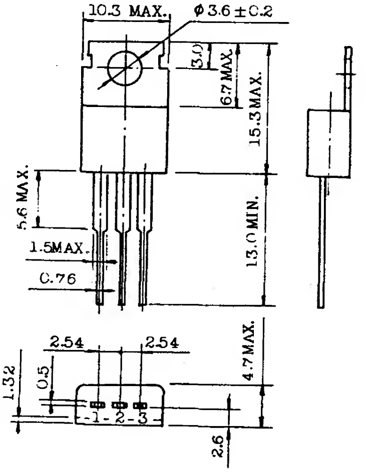
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage

  : $V_{CE(sat)}=-0.4V(Max.)$ at $I_C=-3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s(Typ.)$
- Complementary to 2SC2562.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

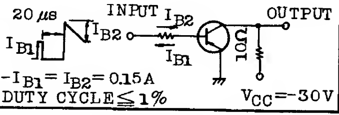
Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

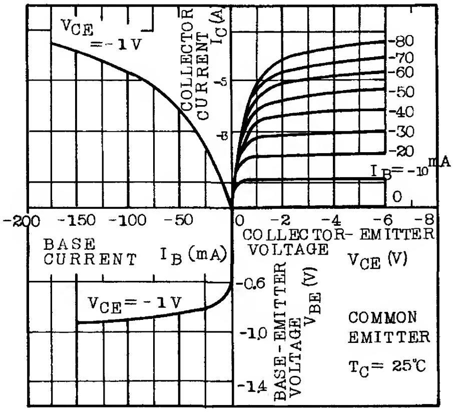
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ∼ 150	°C

ELECTRICAL CHARACTAERISTICS (Ta=25°C)

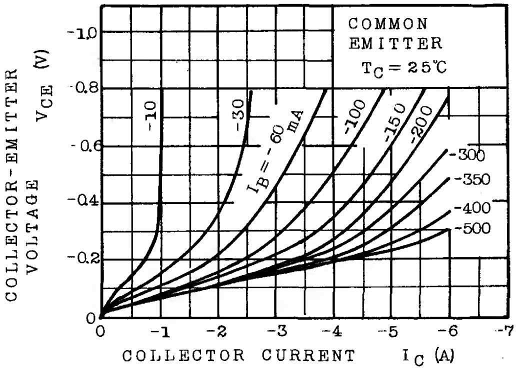
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-50V,\ I_E=0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-10mA,\ I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE}(1)$ (Note)	$V_{CE}=-1V,\ I_C=-1A$	70	-	240	
		$h_{FE}(2)$	$V_{CE}=-1V,\ I_C=-3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.9	-1.2	
Transition Frequencty		f_T	$V_{CE}=-4V,\ I_C=-1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	170	-	pF
Switching Time	Turn-on Time	t_{on}	 $-I_{B1}=I_{B2}=0.15A$ DUTY CYCLE≦1% $V_{CC}=-30V$	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE}(1)$ Classification O : 70∼140, Y : 120∼240

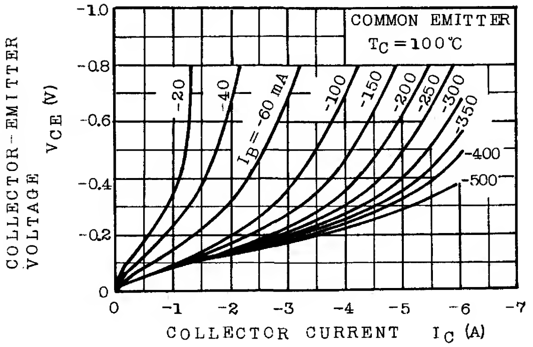
STATIC CHARACTERISTICS



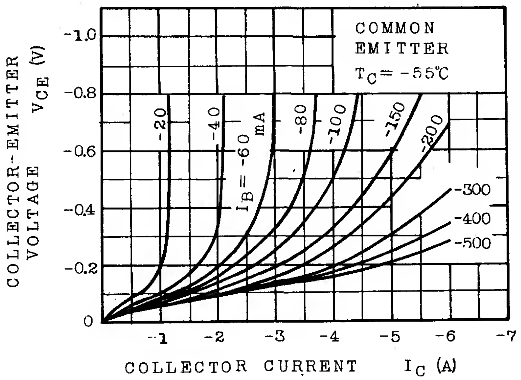
V_{CE} – I_C



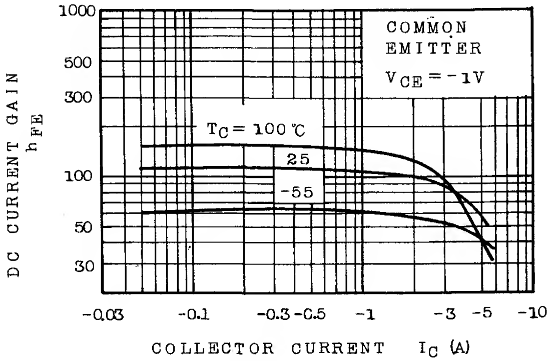
V_{CE} – I_C



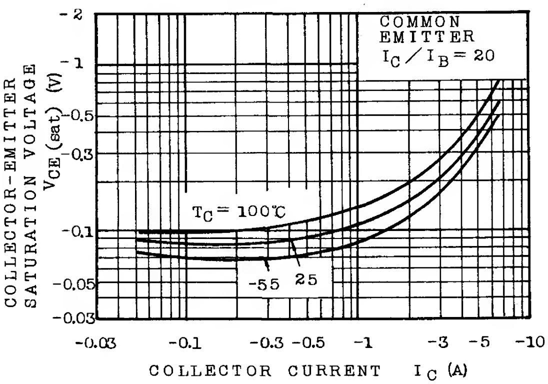
V_{CE} – I_C



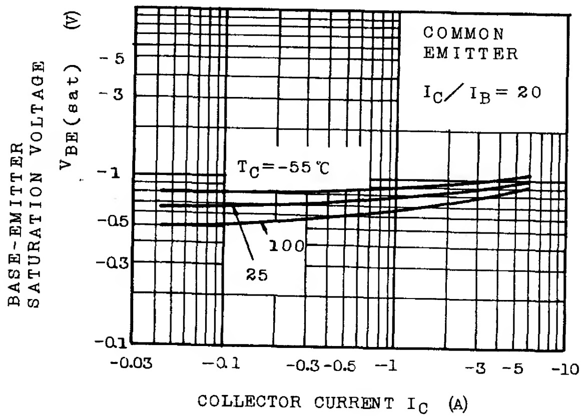
h_{FE} – I_C



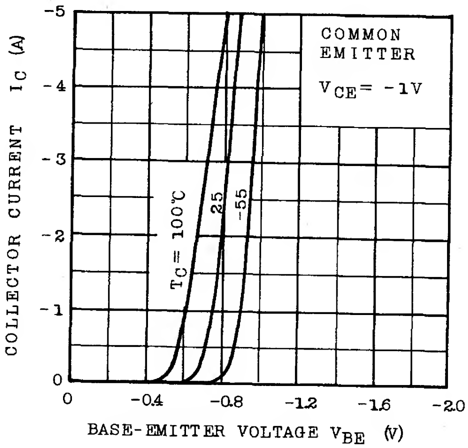
$V_{CE(sat)}$ – I_C



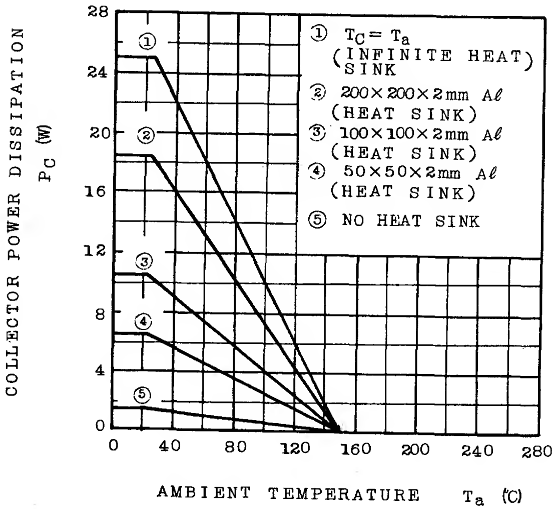
$V_{BE(sat)} - I_C$



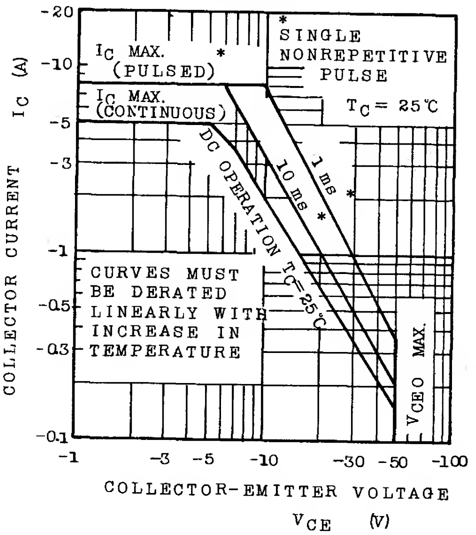
$I_C - V_{BE}$



$P_C - T_a$



SAFE OPERATING AREA



2SA1021

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

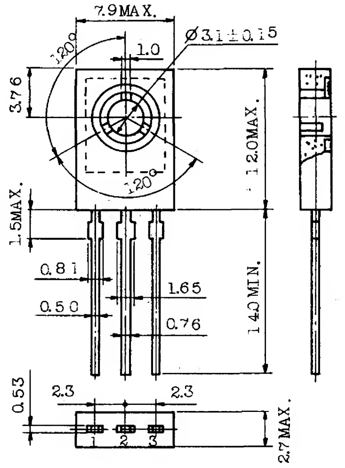
COLOR TV VERT. DEFLECTION OUTPUT APPLICATIONS.

COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability.
- Recommended for Vert. Deflection Output & Sound Output Applications for Line Operated TV.
- Complementary to 2SC2481.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	—
TOSHIBA	2−8F1A

Mounting Kit No. AC46C
Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

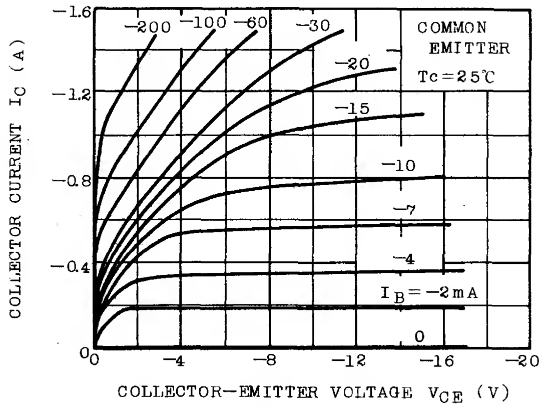
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-150	V
Collector-Emitter Voltage		V_{CEO}	-150	V
Emitter-Base Voltage		V_{EBO}	-6	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-1.0	A
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°)

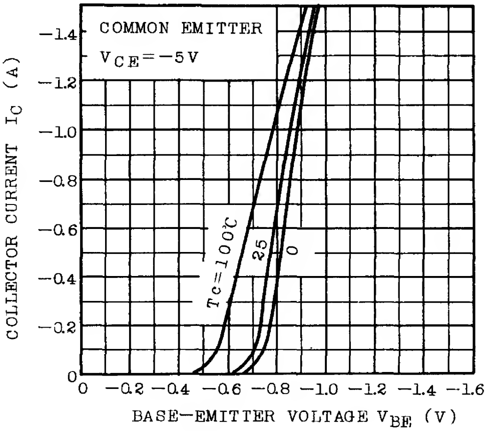
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-150V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-6V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-150	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-200mA	60	-	320	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5mA	-0.5	-	-0.8	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-200mA	15	50	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	35	pF

Note : h_{FE} Classification R:60~120 O:100~200 Y:160~320

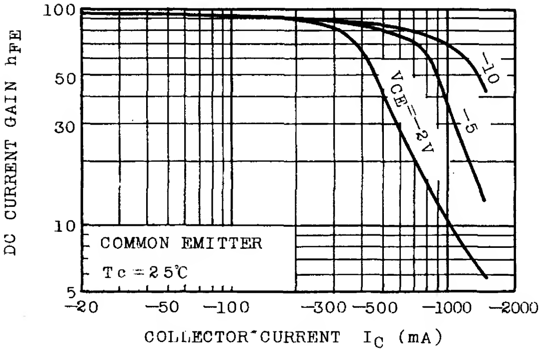
I_C - V_{CE}



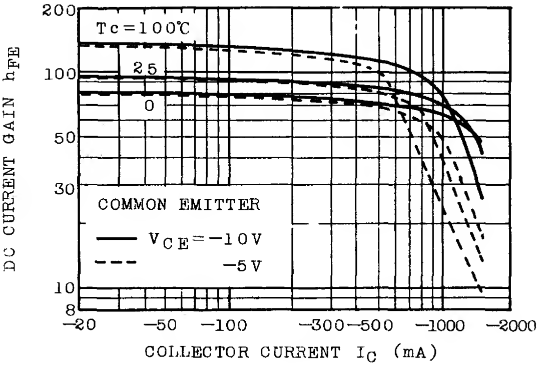
I_C − V_{BE}



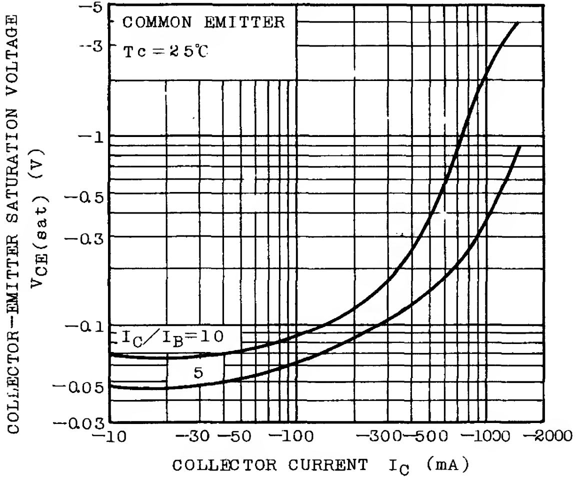
h_{FE} − I_C



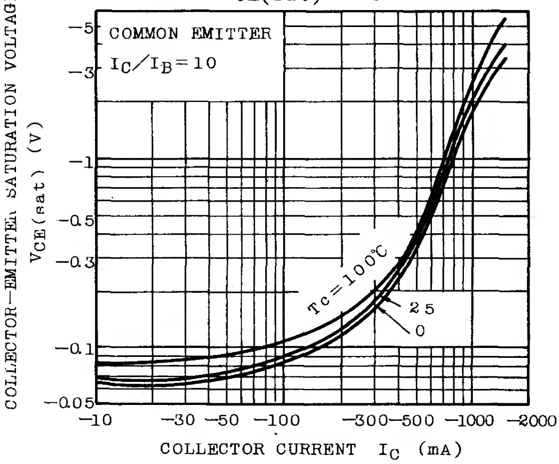
h_{FE} − I_C

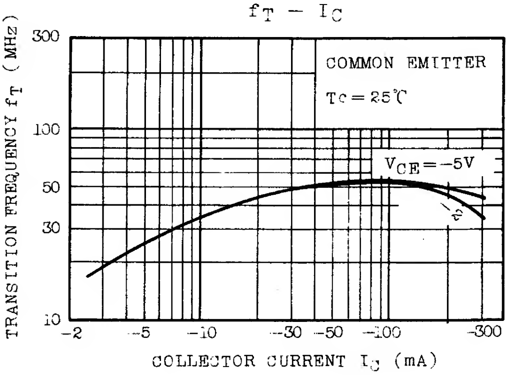


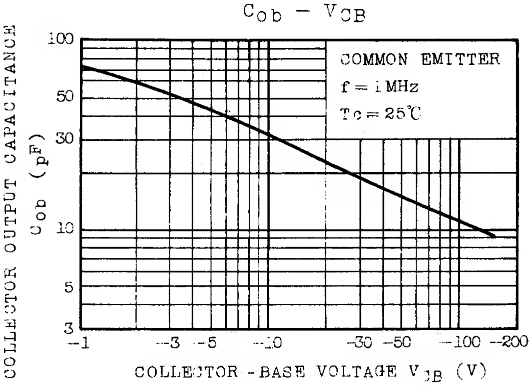
$V_{CE(sat)}$ − I_C

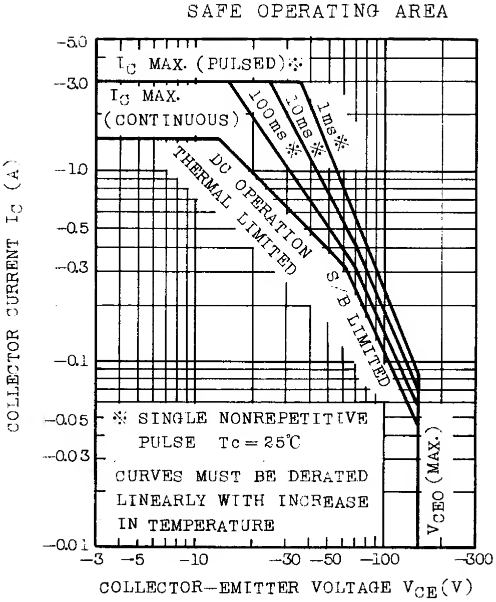


$V_{CE(sat)}$ − I_C




fT — IC
TRANSITION FREQUENCY fT (MHz)
300
100
50
30
10
COMMON EMITTER
Tc = 25℃
VCE = −5V
−2
−5
−10
−30
−50
−100
−300
COLLECTOR CURRENT IC (mA)


Cob — VCB
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
100
50
30
10
5
3
COMMON EMITTER
f = 1 MHz
Tc = 25℃
−1
−3
−5
−10
−30
−50
−100
−200
COLLECTOR - BASE VOLTAGE VCB (V)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
−5.0
−3.0
−1.0
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
IC MAX. (PULSED)※
IC MAX. (CONTINUOUS)
100ms※
10ms※
1ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
VCEO (MAX.)
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
−3
−5
−10
−30
−50
−100
−300
COLLECTOR−EMITTER VOLTAGE VCE (V)

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

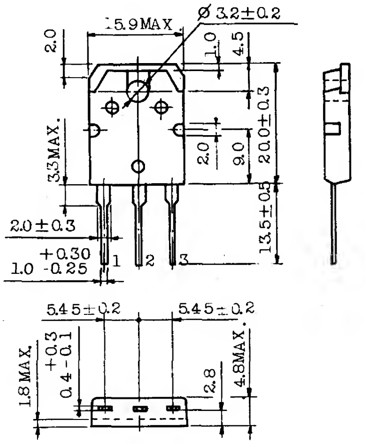
2SA1093

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC2563.
- Recommended for 50W audio amplifier output stage.
- High transition frequency : f_T=90MHz(Typ.)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

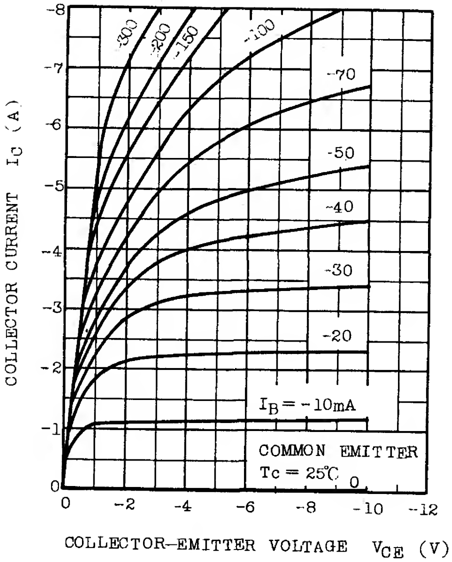
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-120	V
Collector-Emitter Voltage	V_{CEO}	-120	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-8	A
Base Current	I_B	-0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

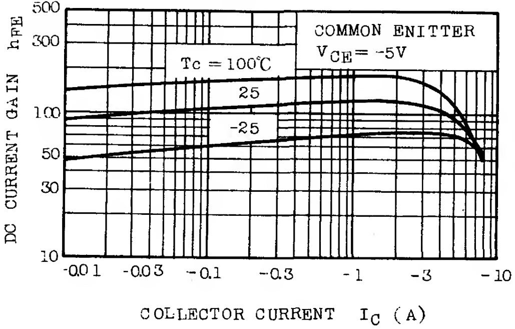
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-120V, I_E=0	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-0.05A, I_B=0	-120	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	240	
	$h_{FE}(2)$	V_{CE}=-5V, I_C=-4A	30	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-1.0	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-4A	-	-1.5	-2.5	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	-	90	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	150	-	pF

Note: $h_{FE}(1)$ Classification. R:55~110, O:80~160, Y:120~240

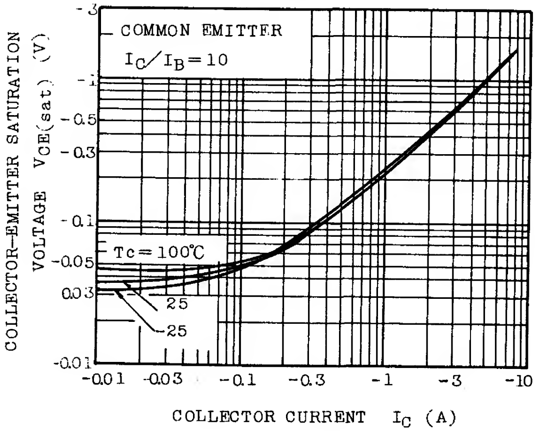
$I_C - V_{CE}$



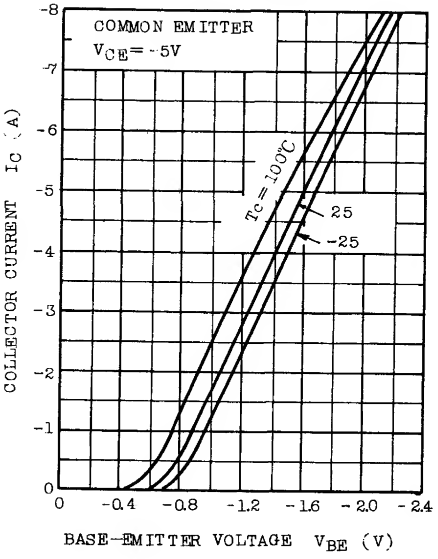
$h_{FE} - I_C$



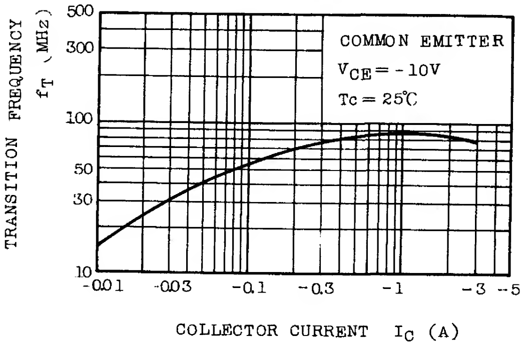
$V_{CE(sat)} - I_C$

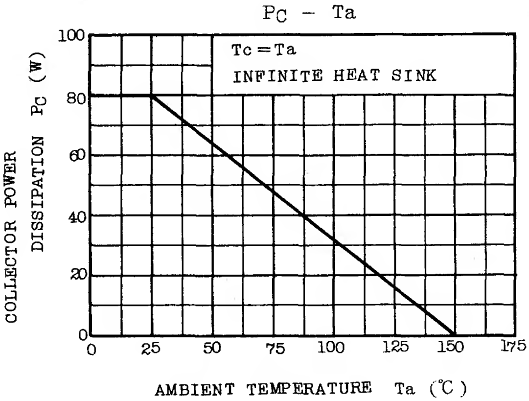


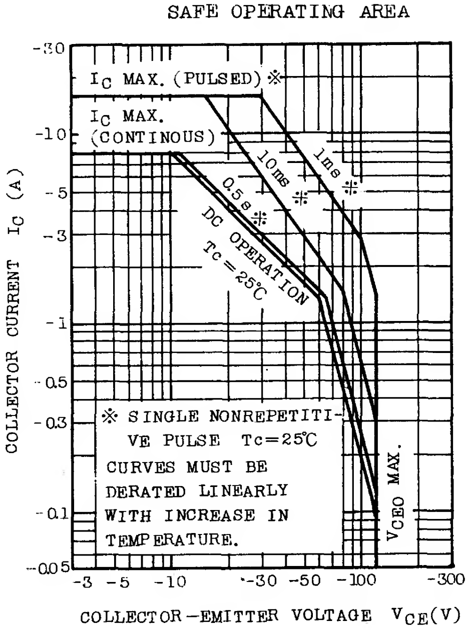
$I_C - V_{BE}$



$f_T - I_C$




PC - Ta
Tc = Ta
INFINITE HEAT SINK
100
80
60
40
20
0
0
25
50
75
100
125
150
175
COLLECTOR POWER DISSIPATION PC (W)
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX. (PULSED) ※
IC MAX. (CONTINOUS)
1ms ※
10ms ※
0.5s ※
DC OPERATION Tc = 25℃
VCEO MAX.
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
-30
-10
-5
-3
-1
-0.5
-0.3
-0.1
-0.05
-3
-5
-10
-30
-50
-100
-300
COLLECTOR CURRENT IC (A)
COLLECTOR-EMITTER VOLTAGE VCE(V)

2SA1094

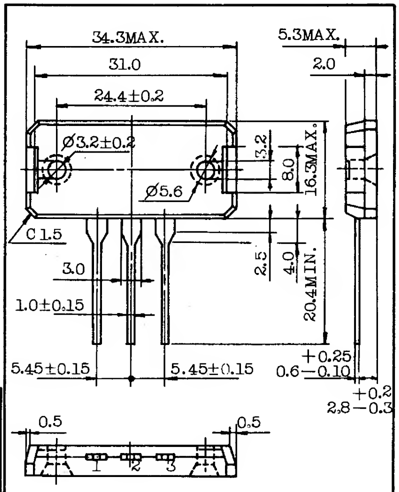
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=-140V
- High Transition Frequency : f_T=70MHz (Typ.)
- Complementary to 2SC2564.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 − 34A1A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

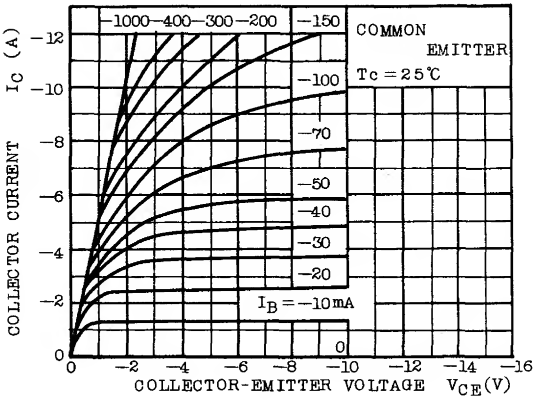
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-140	V
Collector-Emitter Voltage	V_{CEO}	-140	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-12	A
Emitter Current	I_E	12	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

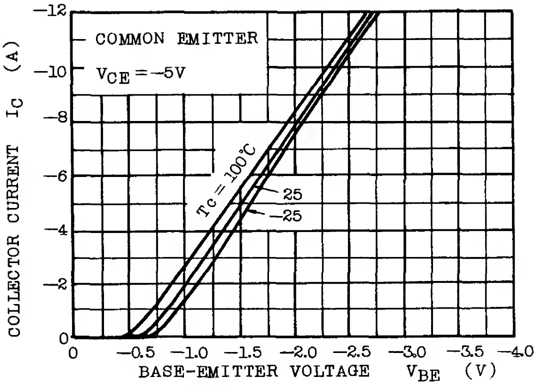
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-140V, I_E=0	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-0.1A, I_B=0	-140	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-0.01A, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-5A	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-	-2.0	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	-	70	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	220	-	pF

Note : $h_{FE(1)}$ Classification R : 55∿110, O : 80∿160, Y : 120∿240

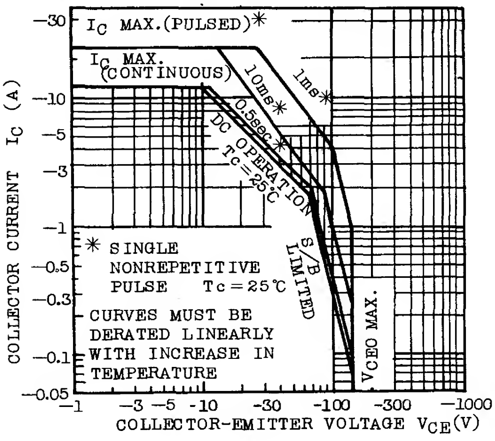
I_C – V_{CE}



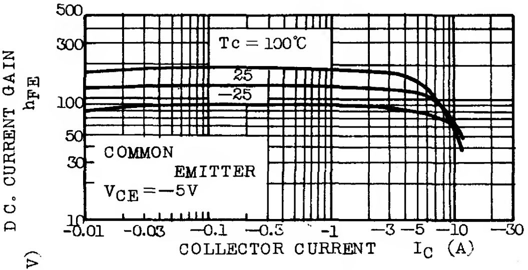
I_C – V_{BE}



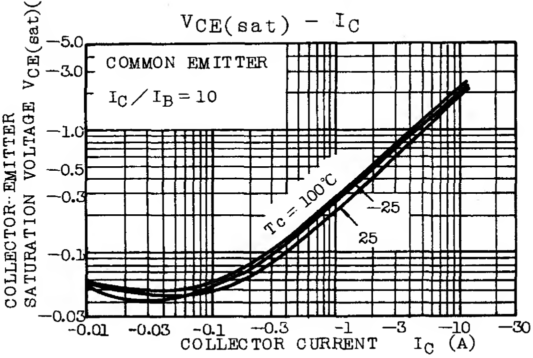
SAFE OPERATING AREA



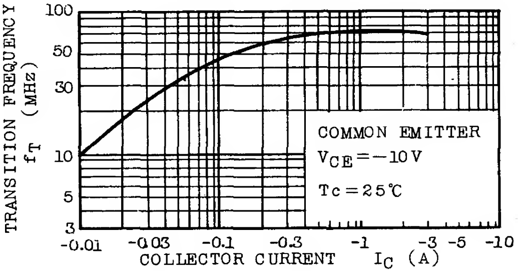
h_{FE} – I_C



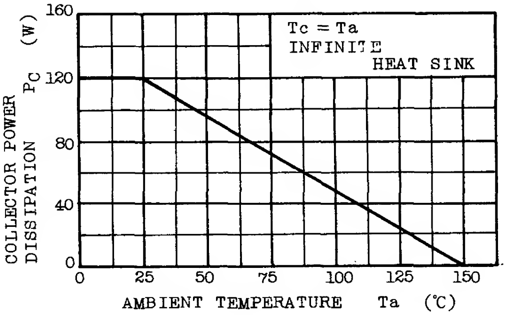
$V_{CE(sat)}$ – I_C



f_T – I_C



P_C – Ta



2SA1095

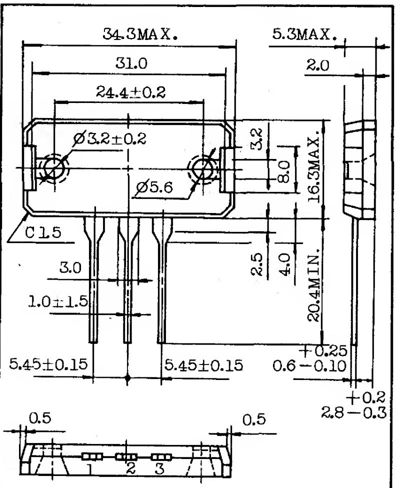
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=-160V
- High Transition Frequency : f_T=60MHz (Typ.)
- Complementary to 2SC2565.
- Recommended for 100W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 34A1A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

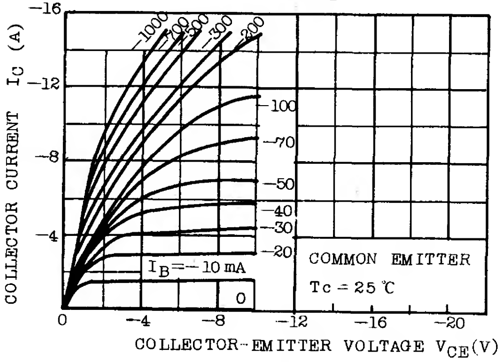
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-160	V
Collector-Emitter Voltage	V_{CEO}	-160	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-15	A
Emitter Current	I_E	15	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

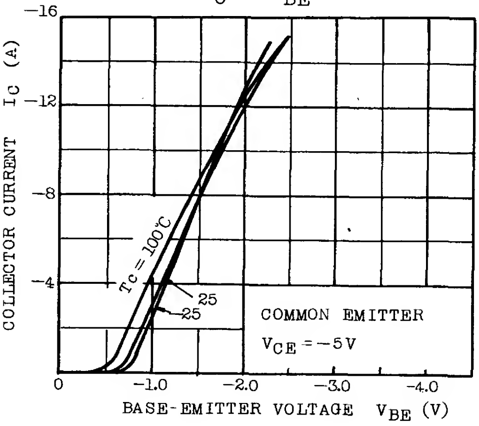
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-160V, I_E=0	–	–	-50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	–	–	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-0.1A, I_B=0	-160	–	–	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-0.01A, I_C=0	-5	–	–	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	–	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-5A	40	–	–	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	–	–	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	–	–	-2.0	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	–	60	–	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	–	350	–	pF

Note : $h_{FE(1)}$ Classification R : 55∿110, O : 80∿160, Y : 120∿240

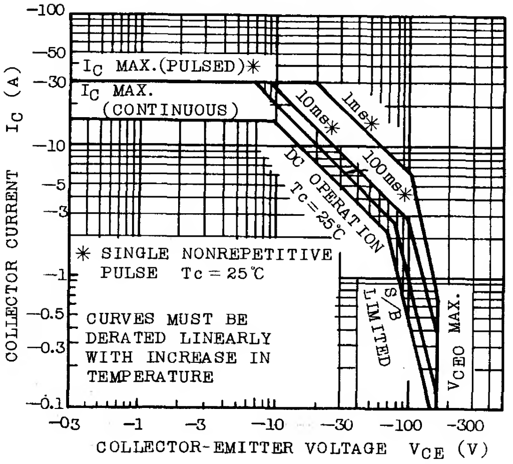
I_C − V_{CE}



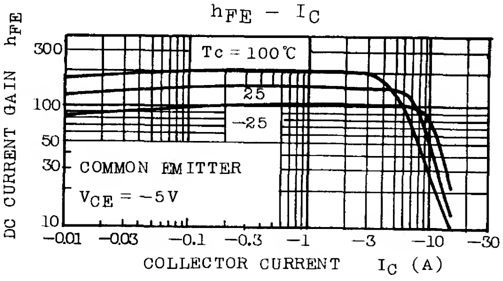
I_C − V_{BE}



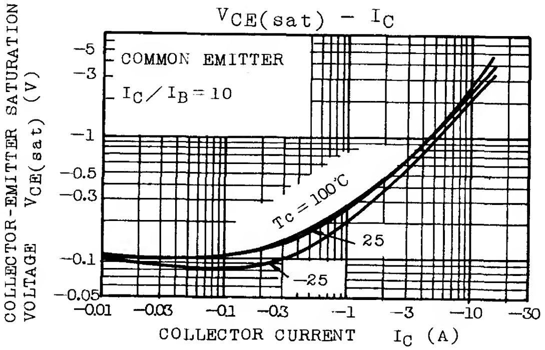
SAFE OPERATING AREA



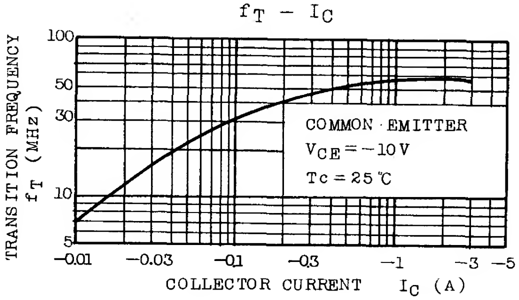
h_{FE} − I_C



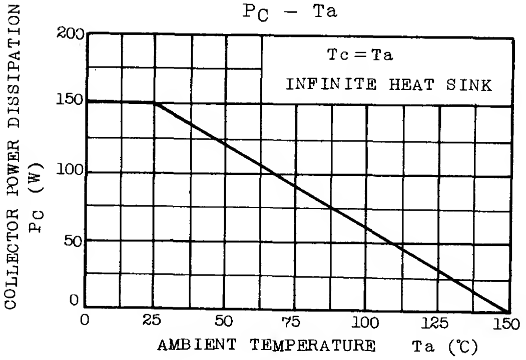
$V_{CE(sat)}$ − I_C



f_T − I_C



P_C − T_a



2SA1120

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

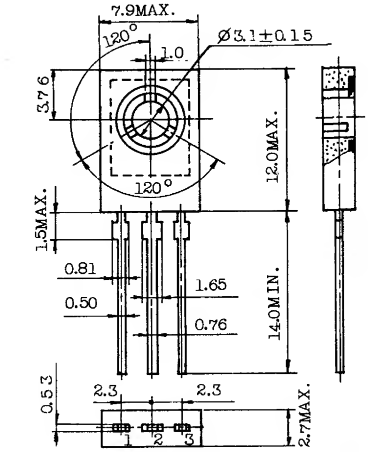
STROBO FLASH APPLICATIONS.

AUDIO POWER AMPLIFIER APPLICATIONS.

FEATURES:

- MIN h_{FE} of 70 at-2V, -4A.
- -5A Rated Collector Current.
- MAX $V_{CE(sat)}$ of -1.0V at -4A I_C.
- 10W at 25°C Case Temperature.

Unit in mm



1. EMITTER 2. COLLECTOR (HEAT SINK) 3. BASE

JEDEC	TO – 126
EIAJ	–
TOSHIBA	2 – 8F1A

Mounting Kit No. AC46C

Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-35	V
Collector-Emitter Voltage		V_{CEO}	-20	V
Emitter-Base Voltage		V_{EBO}	-8	V
Collector Current	DC	I_C	-5	A
	Pulsed(Note 1)	I_{CP}	-8	A
Emitter Current	DC	I_E	5	A
	Pulsed(Note 1)	I_{EP}	8	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

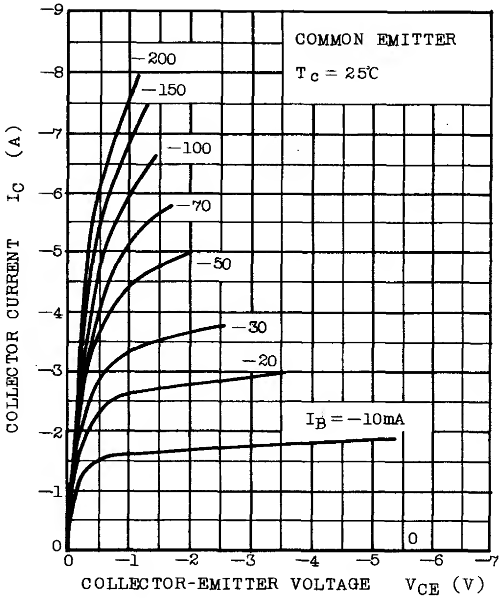
Note 1. Pulse Test : Pulse Width=10ms(Max.), Duty Cycle=30%(Max.)

ELECTRICAL CHARACTERISTICS (Ta=25°C)

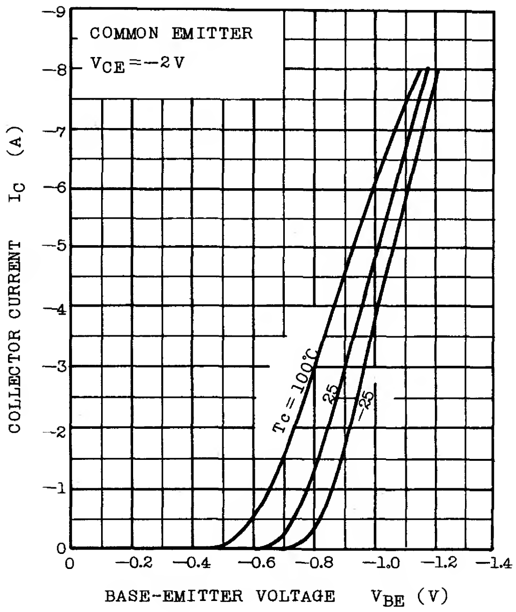
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-35V, I_E=0	-	-	-100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-8V, I_C=0	-	-	-100	nA
Collector-Emitter Breakdown Boltage	V_{CEO}	I_C=-10mA, I_B=0	-20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	I_E=-1mA, I_C=0	-8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	V_{CE}=-2V, I_C=-0.5A	100	-	320	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-4A	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.1A	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	-	170	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	62	-	pF

Note 2. $h_{FE(1)}$ Classification 0:100∿200, Y:160∿320

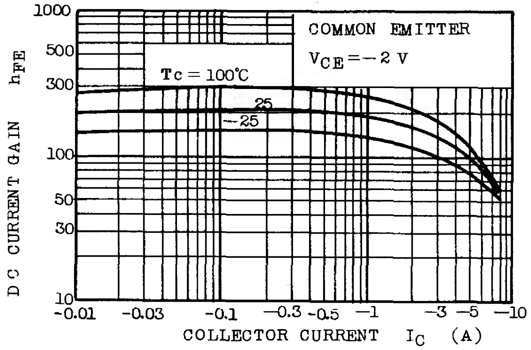
$I_C - V_{CE}$



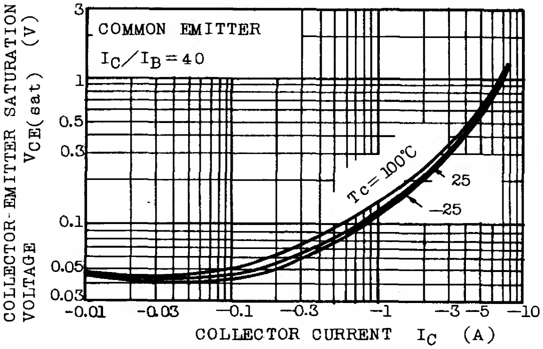
$I_C - V_{BE}$



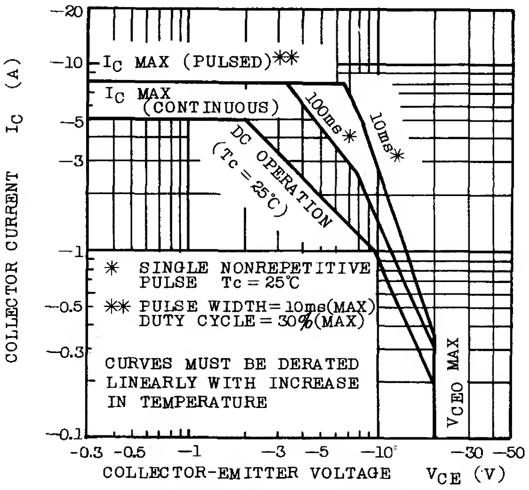
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



2SA1144

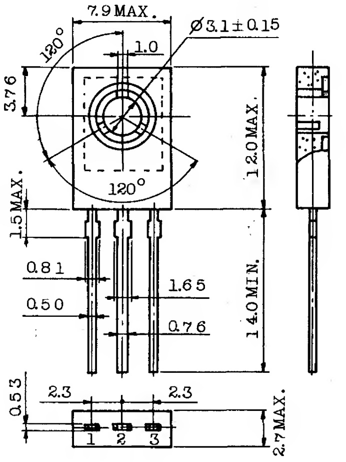
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

AUDIO FREQUENCY AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC2704.
- . Small Collector Output Capacitance : C_{ob}=2.5pF(Typ.)
- . High Transition Frequency : f_T=200MHz(Typ.)

Unit in mm



1. EMITTER
2. COLLECTOR(HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Mounting Kit No. AC46C
Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

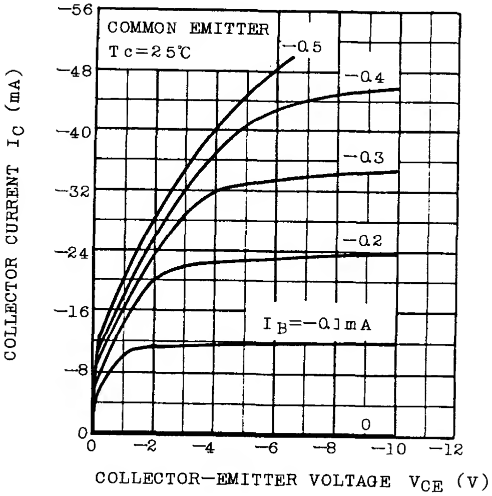
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-150	V
Collector-Emitter Voltage	V_{CEO}	-150	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-50	mA
Base Current	I_B	-5	mA
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

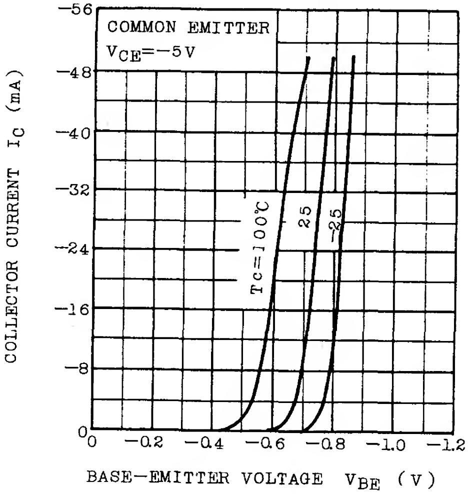
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-150V, I_E=0	-	-	-0.1	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-0.1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-1mA, I_B=0	-150	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-10mA	80	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-10mA, I_B=-1mA	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-10mA	-	-	-0.8	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-10mA	-	200	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	2.5	-	pF

Note: h_{FE} Classification 0:80~160, Y:120~240

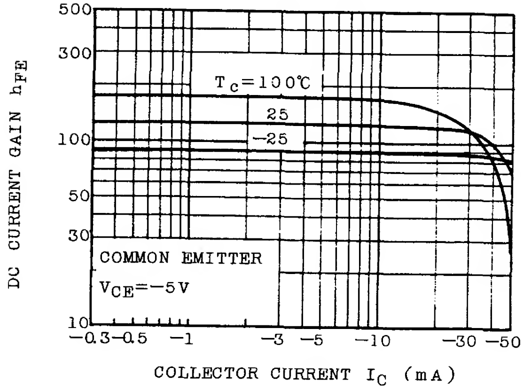
$I_C - V_{CE}$



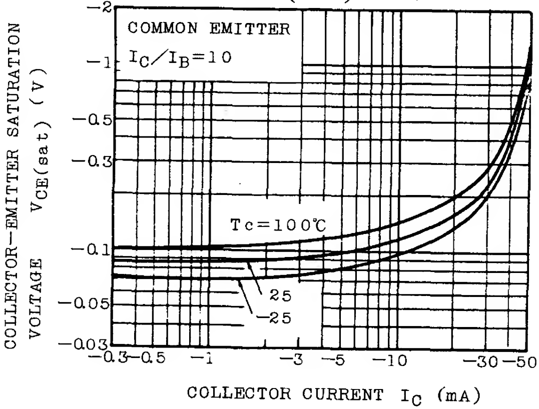
$I_C - V_{BE}$



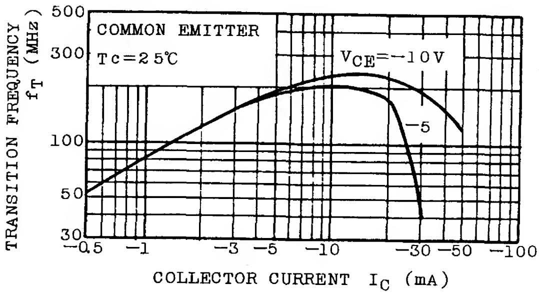
$h_{FE} - I_C$



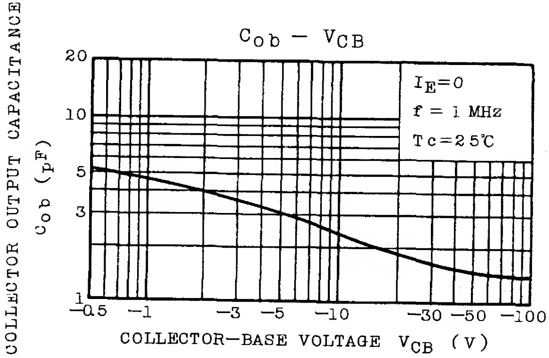
$V_{CE(sat)} - I_C$

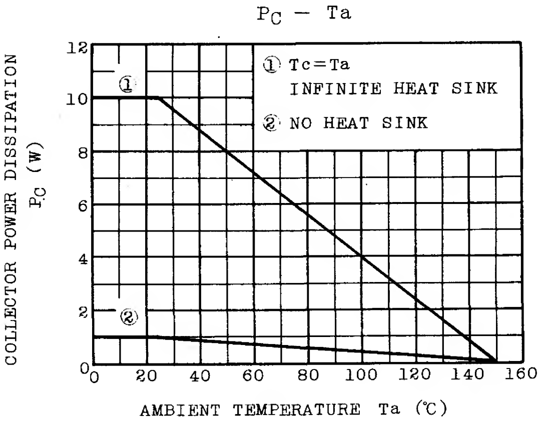


$f_T - I_C$



$C_{ob} - V_{CB}$




P_C — Ta
COLLECTOR POWER DISSIPATION P_C (W)
AMBIENT TEMPERATURE Ta (℃)
① Tc=Ta
INFINITE HEAT SINK
② NO HEAT SINK
①
②
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

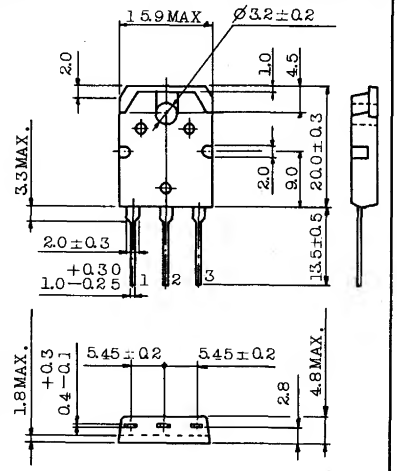
2SA1146

AUDIO FREQUENCY LOW POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC2706.
- Recommended for 70W audio frequency amplifier output stage.
- High transition frequency : f_T=70MHz(Typ.)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

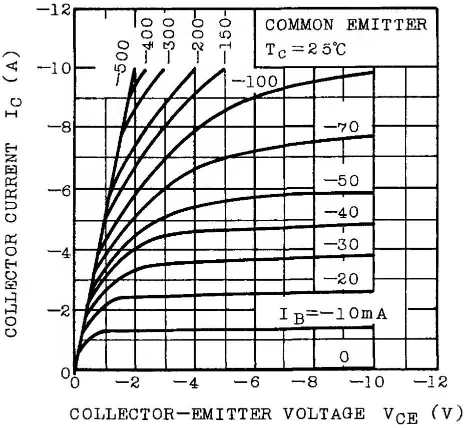
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-140	V
Collector-Emitter Voltage	V_{CEO}	-140	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-10	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

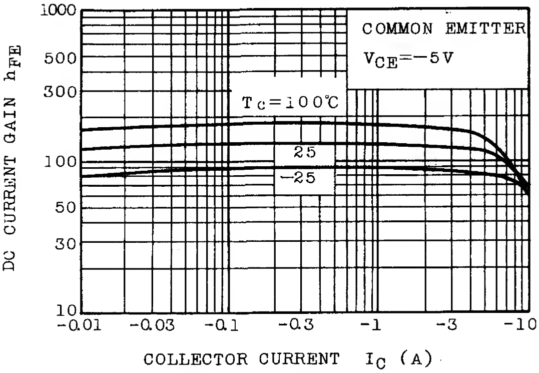
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-140V, I_E=0	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-5A	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-	-2.5	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	-	70	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	220	-	pF

Note: h_{FE} Classification R:55~110, O:80~160, Y:120~240

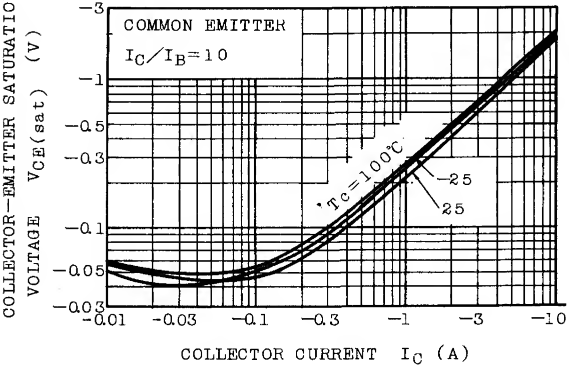
I_C – V_{CE}



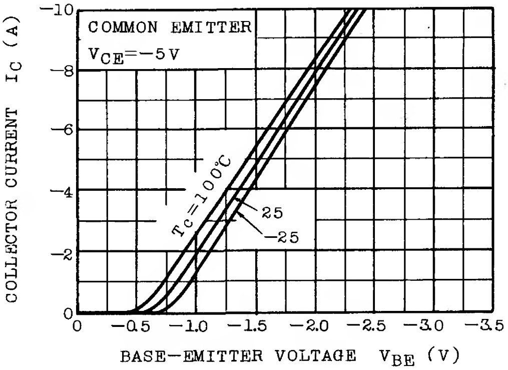
h_{FE} – I_C



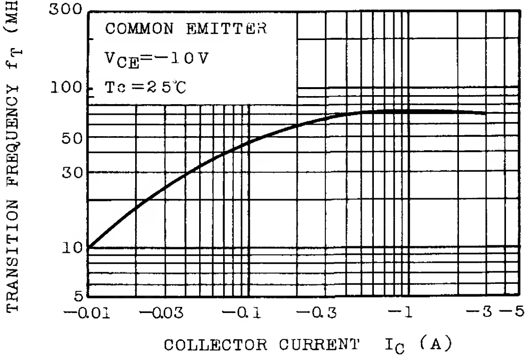
$V_{CE(sat)}$ – I_C



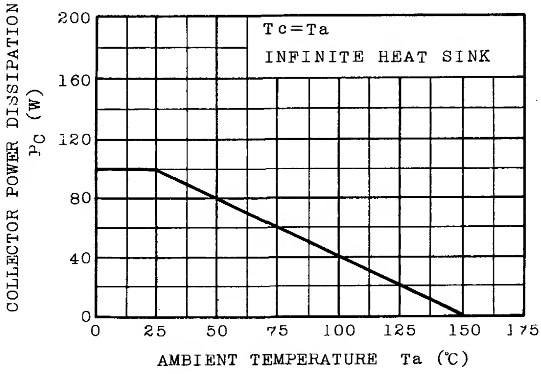
I_C – V_{BE}

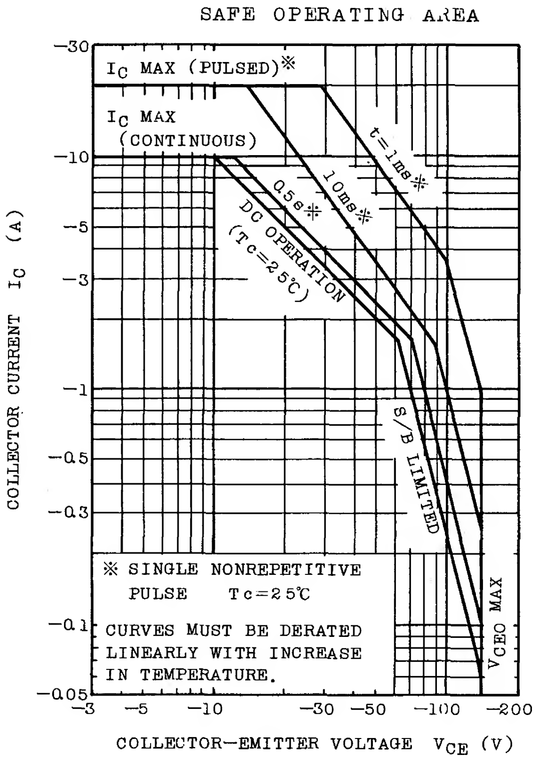


f_T – I_C



P_C – Ta




SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
t=1ms※
10ms※
0.5s※
DC OPERATION (Tc=25°C)
S/B LIMITED
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
COLLECTOR CURRENT IC (A)
−30
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
COLLECTOR−EMITTER VOLTAGE VCE (V)
−3
−5
−10
−30
−50
−100
−200

2SA1184

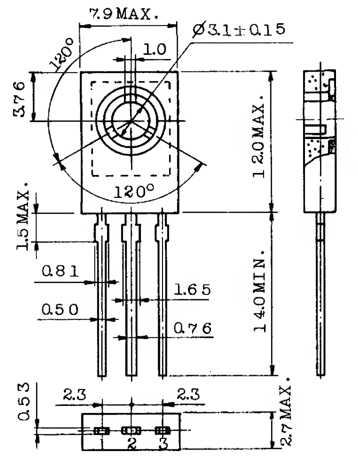
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Complementary to 2SC2824.
- Suitable for driver of 60 to 80 watts.
- High breakdown voltage.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	—
TOSHIBA	2−8F1A

Mounting Kit No. AC46C
Weight : 0.72g

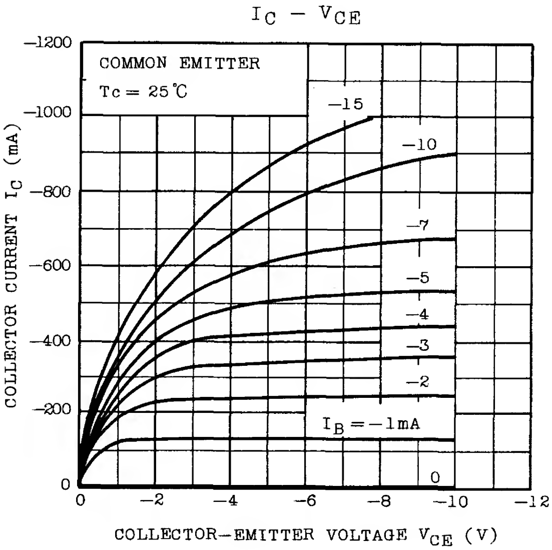
MAXIMUM RATINGS (Ta=25°C)

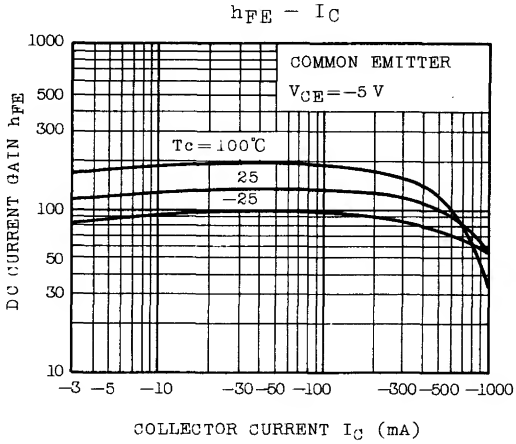
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-120	V
Collector-Emitter Voltage		V_{CEO}	-120	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1	A
Base Current		I_B	-100	mA
Collector Power Dissipation	Ta=25°C	P_C	1	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

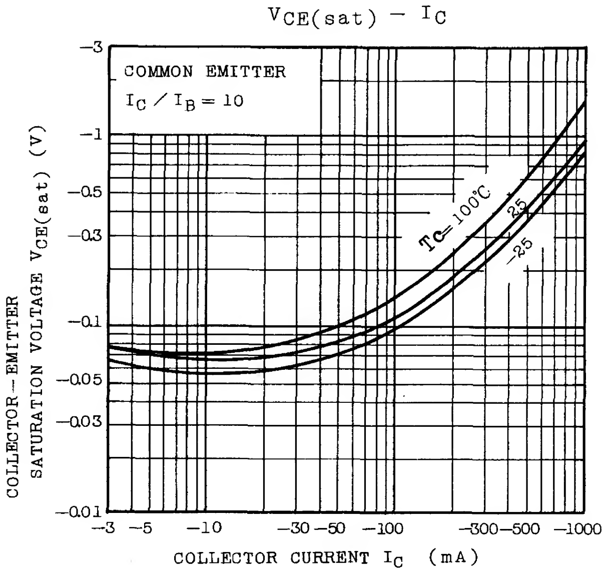
ELECTRICAL CHARACTERISTICS (Ta=25°C)

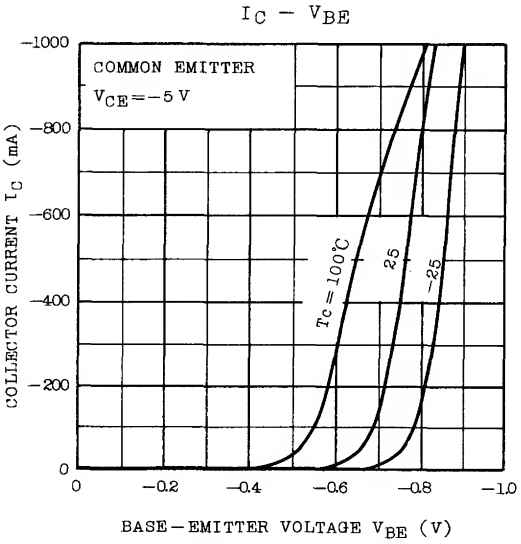
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-120V, I_E=0	-	-	-100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-120	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-1mA, I_C=0	-5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-100mA	80	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-0.40	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-500mA	-	-0.77	-1.0	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-100mA	-	120	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF

Note : h_{FE} Classitication O:80~160 Y:120~240

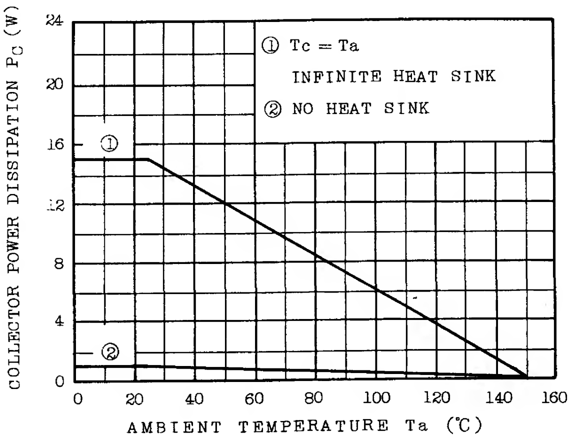

I_C – V_{CE}
COMMON EMITTER
Tc = 25°C
−15
−10
−7
−5
−4
−3
−2
I_B = −1mA
0
COLLECTOR CURRENT I_C (mA)
−1200
−1000
−800
−600
−400
−200
0
0
−2
−4
−6
−8
−10
−12
COLLECTOR−EMITTER VOLTAGE V_{CE} (V)


h_{FE} – I_C
COMMON EMITTER
V_{CE} = −5 V
Tc = 100°C
25
−25
DC CURRENT GAIN h_{FE}
1000
500
300
100
50
30
10
−3
−5
−10
−30
−50
−100
−300
−500
−1000
COLLECTOR CURRENT I_C (mA)

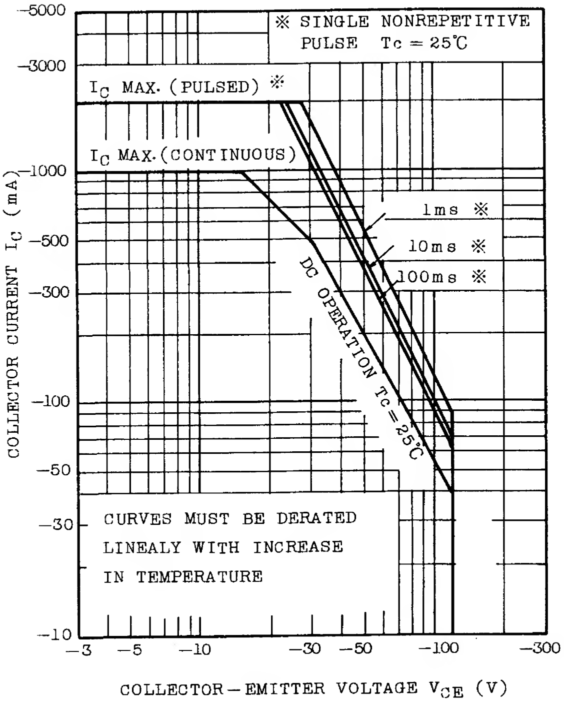

$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C / I_B = 10
Tc = 100°C
25
−25
COLLECTOR−EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
−3
−5
−10
−30
−50
−100
−300
−500
−1000
COLLECTOR CURRENT I_C (mA)


I_C – V_{BE}
COMMON EMITTER
V_{CE} = −5 V
Tc = 100°C
25
−25
COLLECTOR CURRENT I_C (mA)
−1000
−800
−600
−400
−200
0
0
−0.2
−0.4
−0.6
−0.8
−1.0
BASE − EMITTER VOLTAGE V_{BE} (V)

Pc − Ta



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

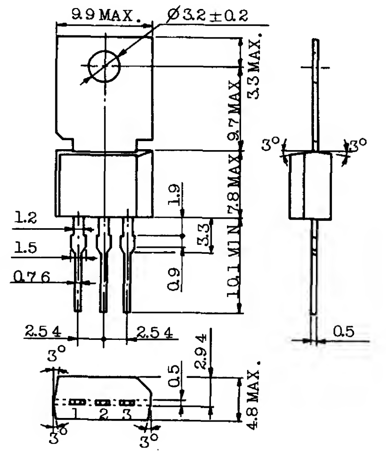
2SA1195

HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.
COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability. (P_C=2.0W at Ta=25°C)
- Designed for Complementary Use with 2SC2483.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	TO-202
EIAJ	–
TOSHIBA	2-10F1B

Weight : 1.37g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-160	V
Collector-Emitter Voltage		V_{CEO}	-160	V
Emitter-Base Voltage		V_{EBO}	-6	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-1.0	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C	P_C	15	
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-150V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-6V, I_C=0	-	-	-1.0	μA
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=-5V, I_C=-200mA	60	-	200	
	$h_{FE}(2)$	V_{CE}=-5V, I_C=-500mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5mA	-0.50	-0.57	-0.70	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-200mA	15	50	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	35	pF

Note : $h_{FE}(1)$ Classification R : 60~120, O : 100~200

2SA1217

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

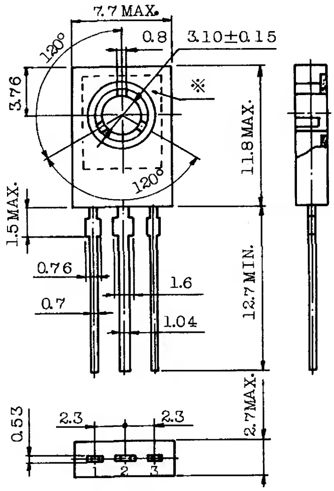
AUDIO FREQUENCY POWER AMPLIFIER

LOW SPEED SWITCHING

FEATURES:

- Suitable for output stage of 5 watts car radio and car stereo.
- Good linearity of h_{FE}.
- Complementary to 2SC2877.

Unit in mm



1. EMITTER
2. COLLECTOR
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

The inside metal of dotted line is connected to collector lead. Weight 0.72 g

MAXIMUM RATINGS (Ta=25°C)

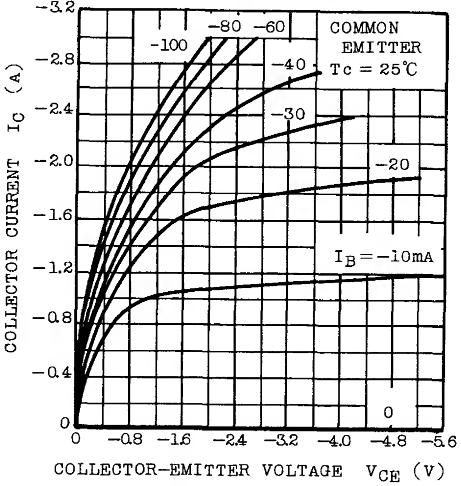
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-40	V
Collector-Emitter Voltage	V_{CEO}	-40	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

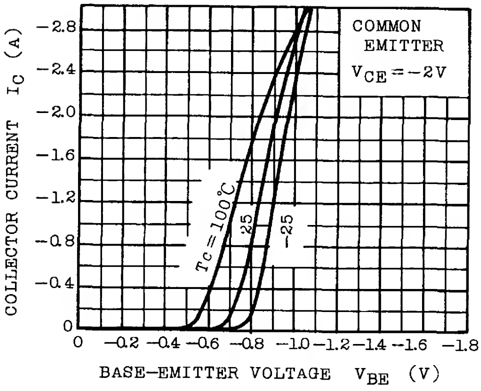
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current	I_{CBO}	V_{CB}=-40V, I_E=0	-	-	-100	nA
Emitter Cutoff Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-40	-	-	V
D.C Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-2V, I_C=-0.5A	80	-	240	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-2.5A	25	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-2A, I_B=-0.2A	-	-	-0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-0.5A	-	-	-1.0	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	-	100	-	MHz
Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	35	-	pF

Note: h_{FE} Classification. O : 80~160 Y : 120~240

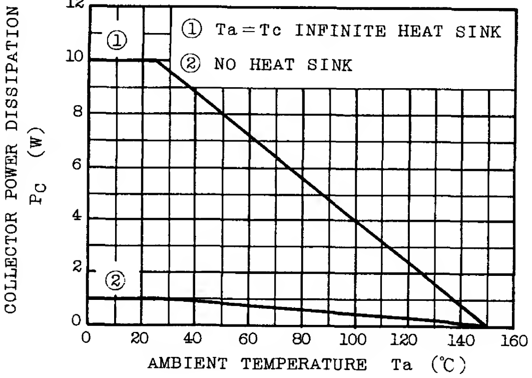
I_C – V_{CE}



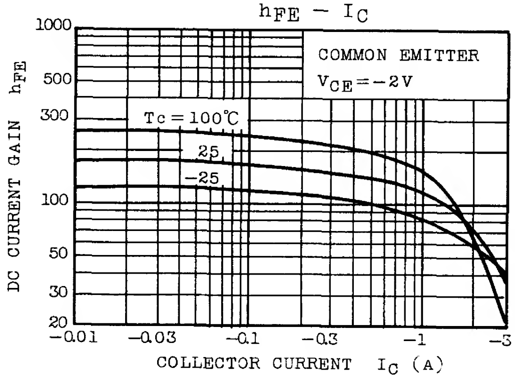
I_C – V_{BE}



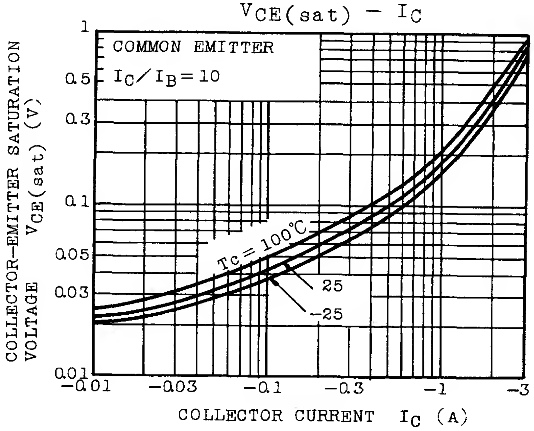
P_C – T_C



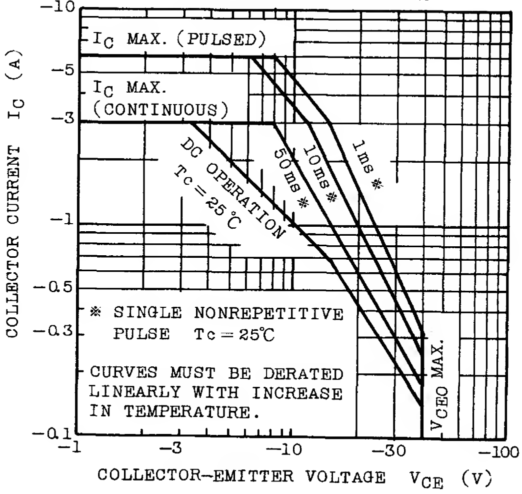
h_{FE} – I_C



$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



2SA1225

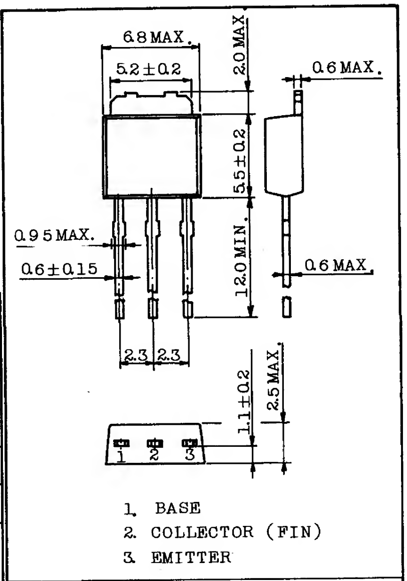
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=100MHz (Typ.)
- Complementary to 2SC2983

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

MAXIMUM RATINGS (Ta=25°C)

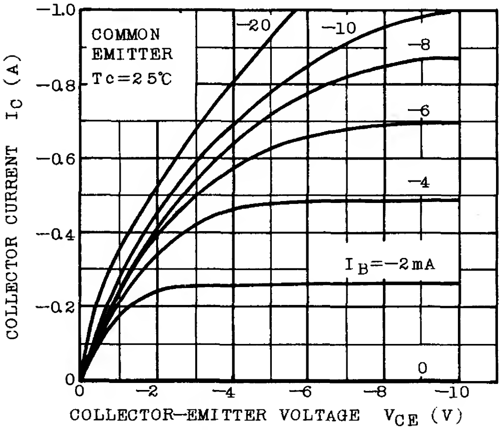
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-160	V
Collector-Emitter Voltage		V_{CEO}	-160	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1.5	A
Base Current		I_B	0.3	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

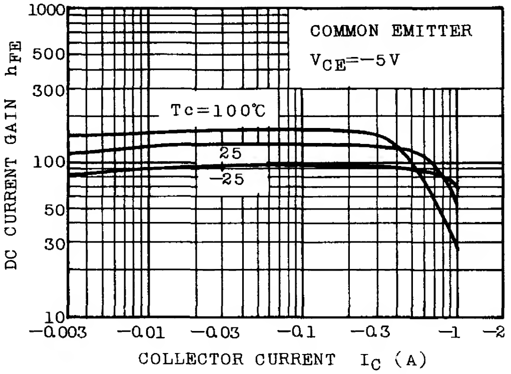
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-160V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-160	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-1mA, I_C=0	-5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-100mA	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-500mA	-	-	-1.0	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-100mA	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF

Note : h_{FE} Classification O : 70~140, Y : 120~240

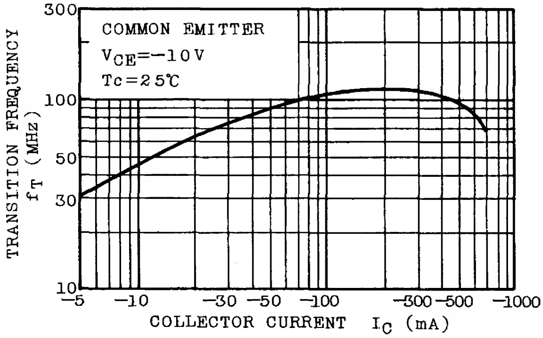
$I_C - V_{CE}$



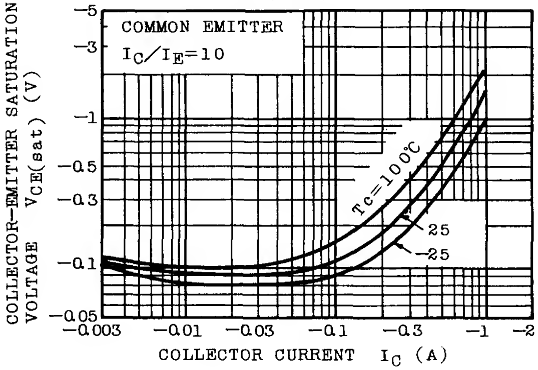
$h_{FE} - I_C$



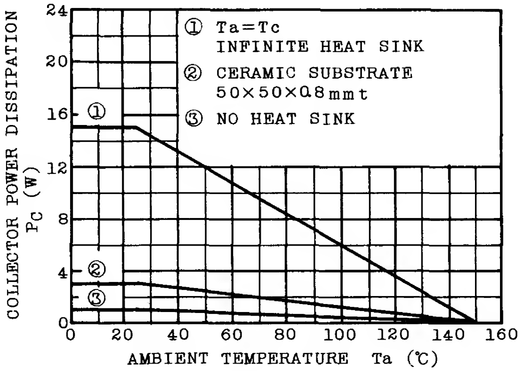
$f_T - I_C$



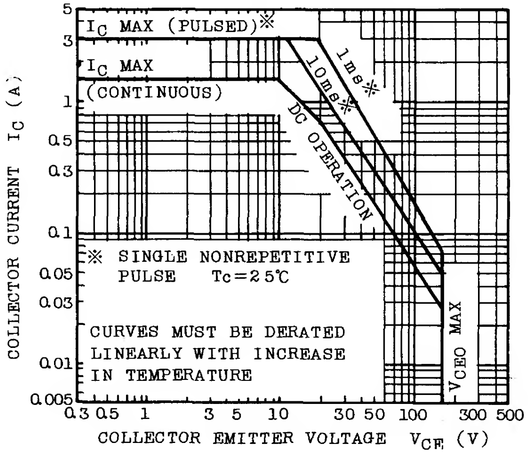
$V_{CE(sat)} - I_C$



$P_C - T_a$



SAFE OPERATING AREA



2SA1241

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

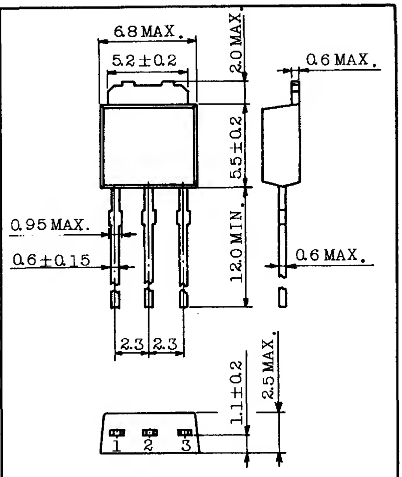
POWER AMPLIFIER APPLICATIONS.

POWER SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.5V$ (Max.) ($I_C=-1A$)
- Excellent Switching Time : $t_{stg}=1.0\mu s$ (Typ.)
- Complementary to 2SC3076

Unit in mm



1. BASE
2. COLLEDTOR (FIN)
3. EMITTER

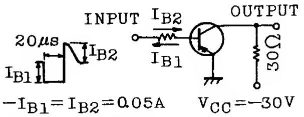
JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

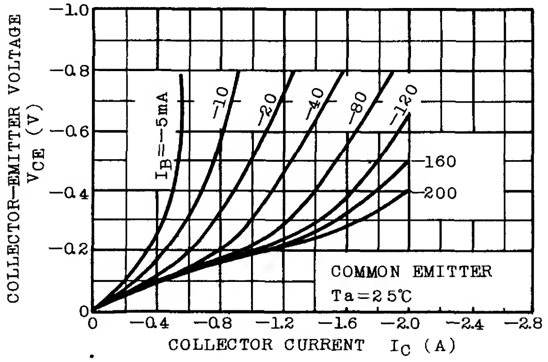
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-50	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-2	A
Base Current		I_B	-1	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.0	W
	$Tc=25^{\circ}C$		10	
Junction Temperature		T_j	150	°C
Storage Temperature		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

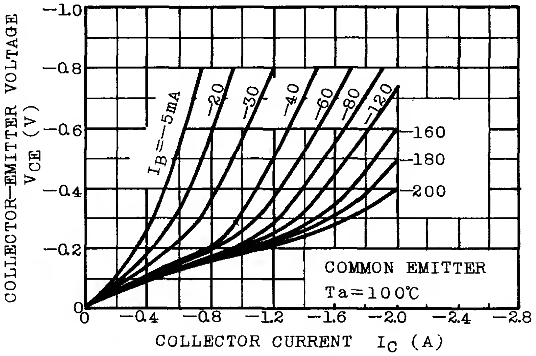
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-50V,\ I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-10mA,\ I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-2V,\ I_C=-0.5A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-2V,\ I_B=-1.5A$	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-1A,\ I_B=-0.05A$	-	-	-0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-1A,\ I_B=-0.05A$	-	-	-1.2	V
Transition Frequency		f_T	$V_{CE}=-2V,\ I_C=-0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	40	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT 20μs I_{B2} I_{B1} 30Ω $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.05A$ DUTY CYCLE≦1%	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～140

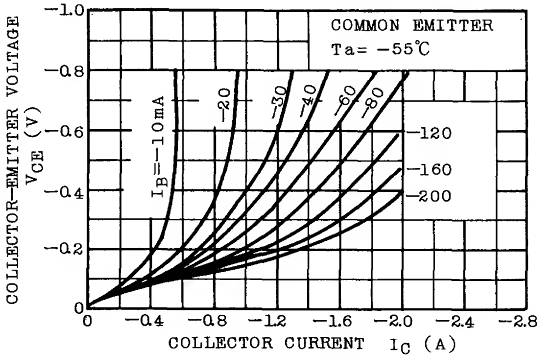
$V_{CE} - I_C$



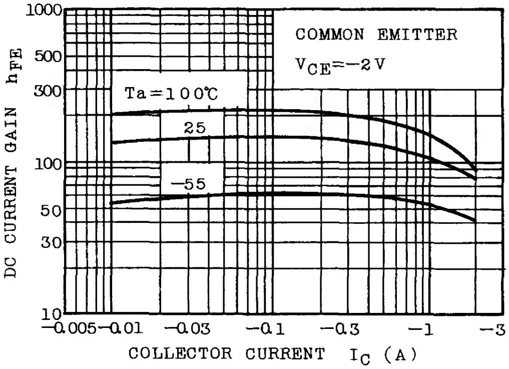
$V_{CE} - I_C$



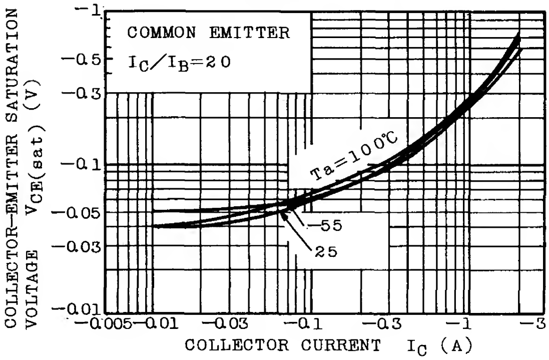
$V_{CE} - I_C$



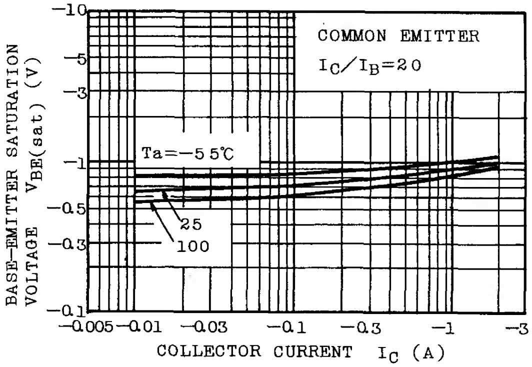
$h_{FE} - I_C$

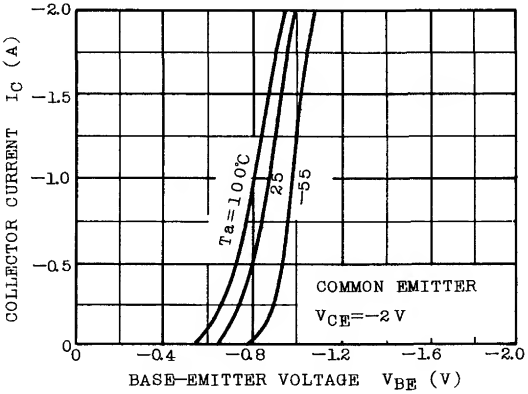


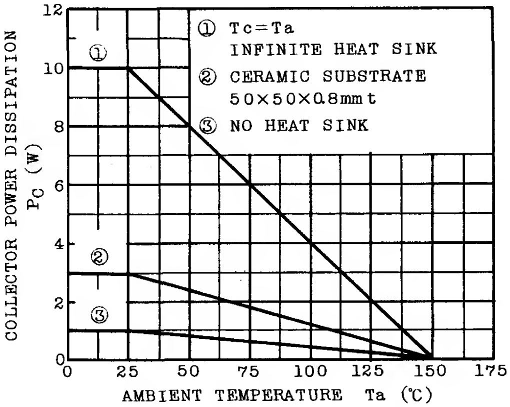
$V_{CE(sat)} - I_C$

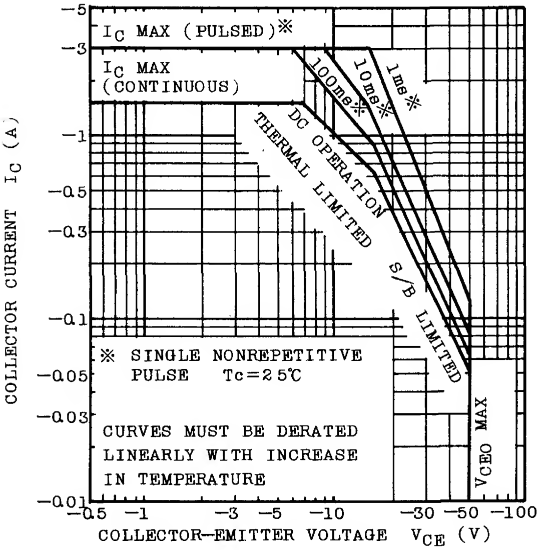


$V_{BE(sat)} - I_C$




I_C – V_{BE}


P_C – Ta


SAFE OPERATING AREA

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1242

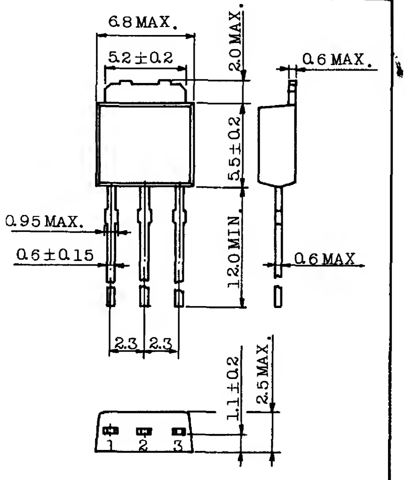
STROBO FLASH APPLICATIONS.

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- h_{FE}=100～320 (V_{CE}=-2V, I_C=-0.5A)
- h_{FE}=70(Min.) (V_{CE}=-2V, I_C=-4A)
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-1.0V(Max.) (I_C=-4A, I_B=-0.1A)
- High Power Dissipation
  : P_C=10W(Tc=25°C), P_C=1.0W(Ta=25°C)

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-35	V
Collector-Emitter Voltage		V_{CEO}	-20	V
Emitter-Base Voltage		V_{EBO}	-8	V
Collector Current	DC	I_C	-5	A
	Pulsed (Note 1)	I_{CP}	-8	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

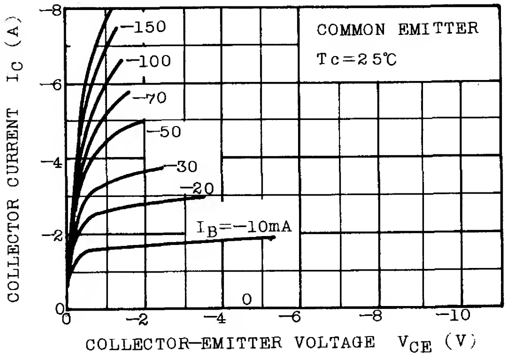
Note 1 : Pulse Test : Pulse width=10ms(Max.), Duty cycle=30%(Max.)

ELECTRICAL CHARACTERISTICS (Ta=25°C)

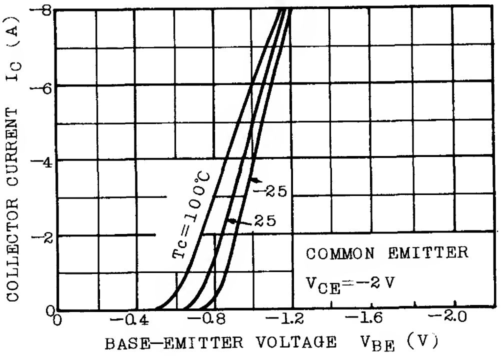
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-35V, I_E=0	-	-	-100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-8V, I_C=0	-	-	-100	nA
Collector-Emitter Breakdown Voltage	V_{CEO}	I_C=-10mA, I_B=0	-20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	I_E=-1mA, I_C=0	-8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	V_{CE}=-2V, I_C=-0.5A	100	-	320	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-4A	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.1A	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	-	170	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	62	-	pF

Note 2 : $h_{FE(1)}$ Classification O : 100～200, Y : 160～320

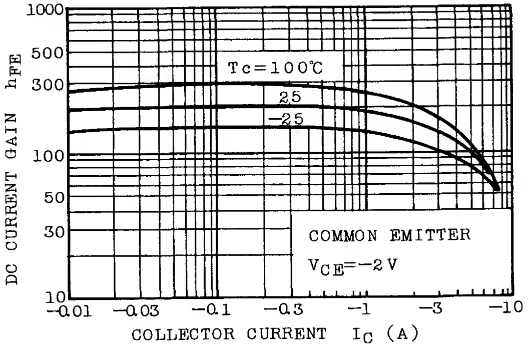
$I_C - V_{CE}$



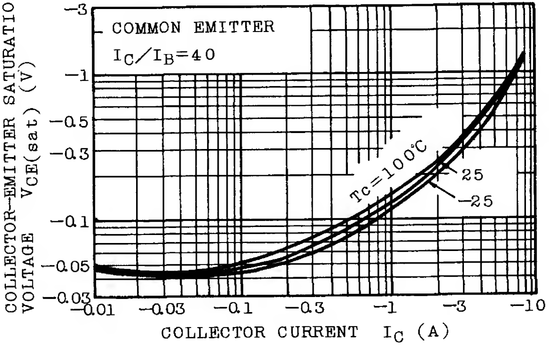
$V_{BE} - I_C$



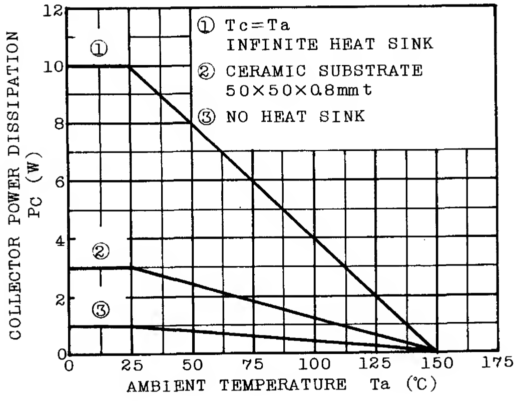
$h_{FE} - I_C$



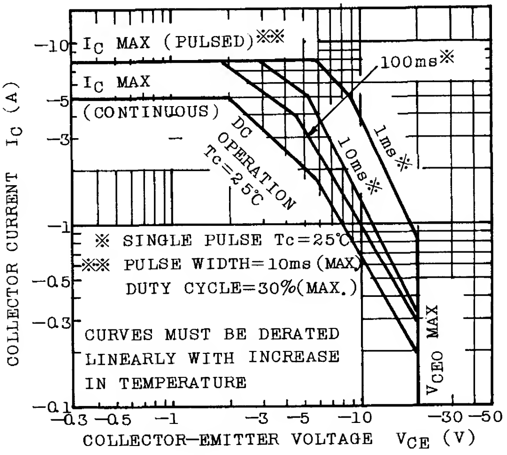
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1243

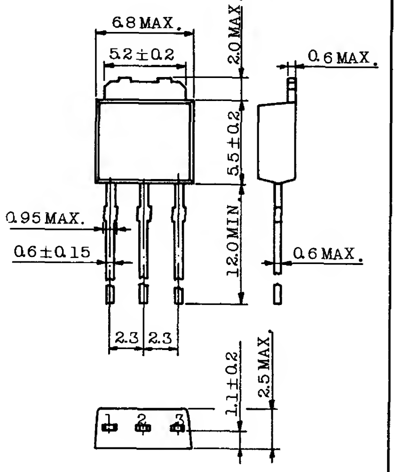
POWER AMPLIFIER APPLICATIONS.

CAR RADIO AND CAR STEREO OUTPUT STAGE APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SC3073

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2–7B1A

Weight : 0.36g

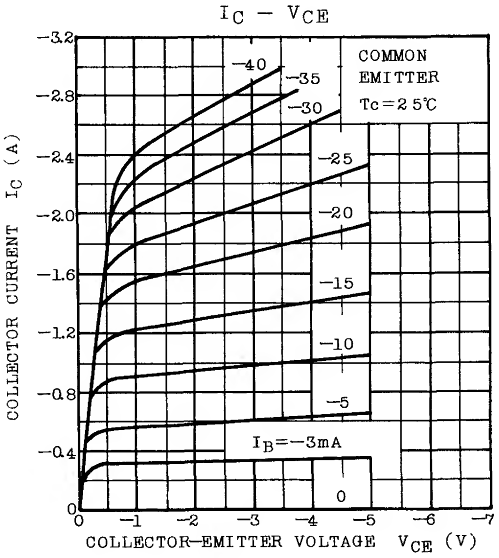
MAXIMUM RATINGS ($Ta=25^{\circ}C$)

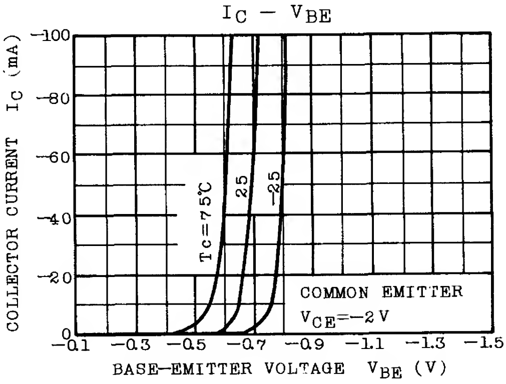
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-30	V
Collector-Emitter Voltage		V_{CEO}	-30	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.6	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.0	W
	$Tc=25^{\circ}C$		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~150	°C

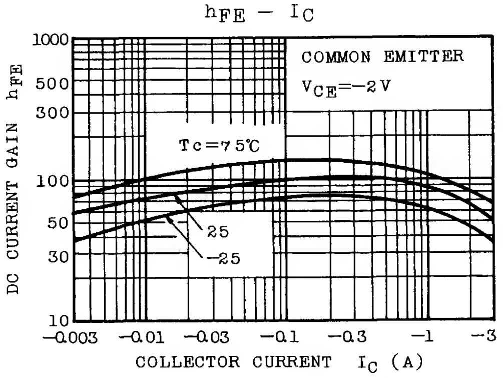
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

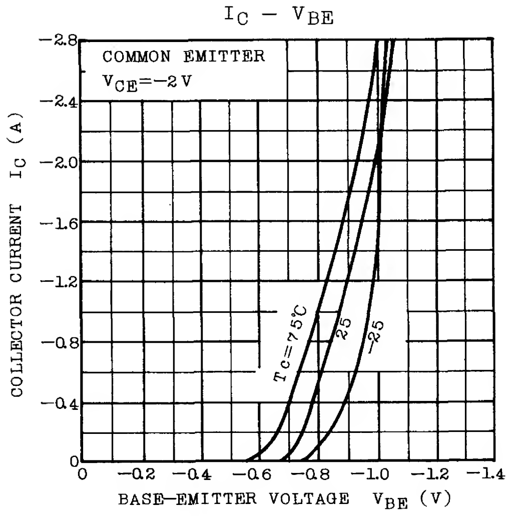
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-20V$, $I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10mA$, $I_B=0$	-30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=-1mA$, $I_C=0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-2V$, $I_C=-0.5A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=-2V$, $I_C=-2.5A$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2A$, $I_B=-0.2A$	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2V$, $I_C=-0.5A$	-	-0.75	-1.0	V
Transition Frequency	f_T	$V_{CE}=-2V$, $I_C=-0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V$, $I_E=0$, f=1MHz	-	40	-	pF

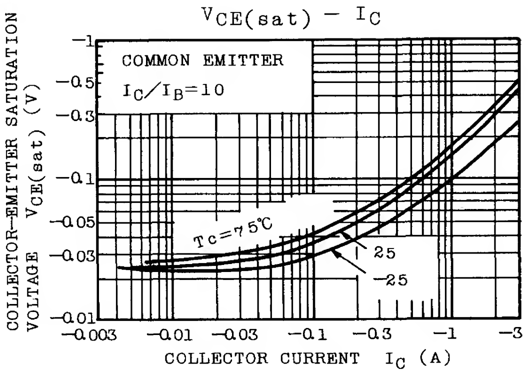
Note: $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

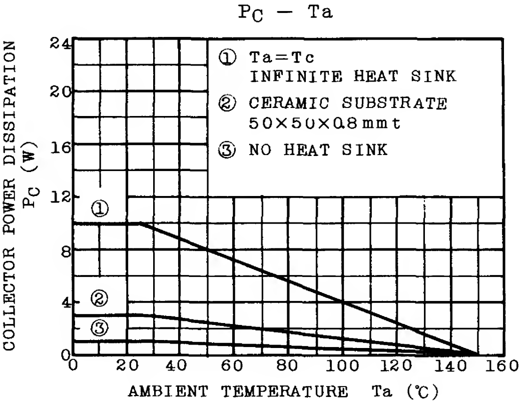

I_C – V_{CE}
COMMON EMITTER
Tc=25℃
−40
−35
−30
−25
−20
−15
−10
−5
I_B=−3mA
0
−3.2
−2.8
−2.4
−2.0
−1.6
−1.2
−0.8
−0.4
0
0 −1 −2 −3 −4 −5 −6 −7
COLLECTOR CURRENT I_C (A)
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

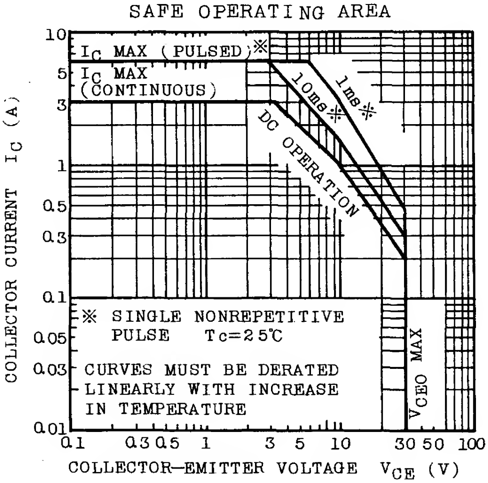

I_C – V_{BE}
Tc=75℃
25
−25
COMMON EMITTER
V_{CE}=−2V
−100
−80
−60
−40
−20
0
−0.1 −0.3 −0.5 −0.7 −0.9 −1.1 −1.3 −1.5
COLLECTOR CURRENT I_C (mA)
BASE–EMITTER VOLTAGE V_{BE} (V)


h_{FE} – I_C
COMMON EMITTER
V_{CE}=−2V
Tc=75℃
25
−25
1000
500
300
100
50
30
10
−0.003 −0.01 −0.03 −0.1 −0.3 −1 −3
DC CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C (A)


I_C – V_{BE}
COMMON EMITTER
V_{CE}=−2V
Tc=75℃
25
−25
−2.8
−2.4
−2.0
−1.6
−1.2
−0.8
−0.4
0
0 −0.2 −0.4 −0.6 −0.8 −1.0 −1.2 −1.4
COLLECTOR CURRENT I_C (A)
BASE–EMITTER VOLTAGE V_{BE} (V)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B=10
Tc=75℃
25
−25
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
−0.003 −0.01 −0.03 −0.1 −0.3 −1 −3
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
COLLECTOR CURRENT I_C (A)


PC — Ta
COLLECTOR POWER DISSIPATION PC (W)
0
4
8
12
16
20
24
① Ta=Tc INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8 mmt
③ NO HEAT SINK
①
②
③
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
10ms※
1ms※
DC OPERATION
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
0.1
0.3
0.5
1
3
5
10
30
50
100
COLLECTOR-EMITTER VOLTAGE VCE (V)

2SA1244

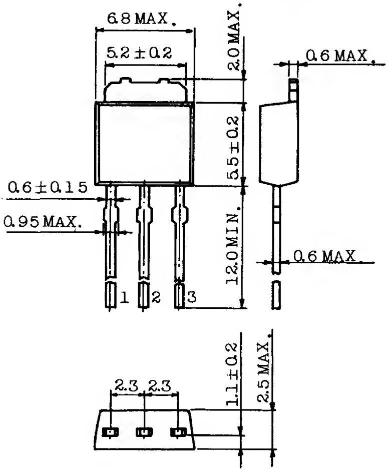
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.4V$ (Max.) at $I_C=-3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$ (Typ.)
- Complementary to 2SC3074

Unit in mm



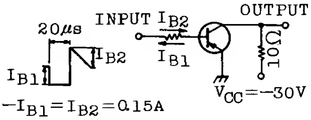
1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

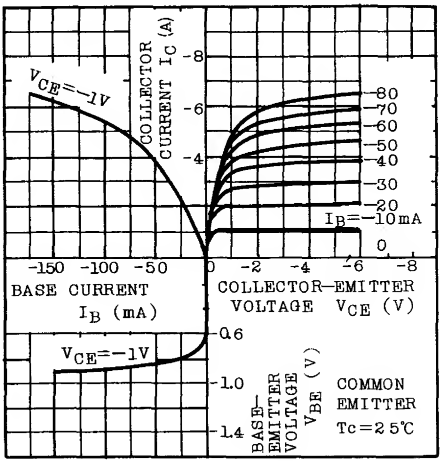
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-5	A
Base Current		I_B	-1	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

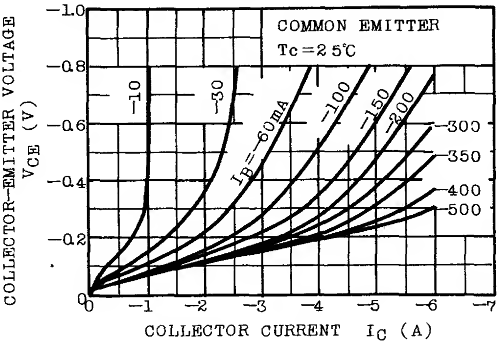
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-50V,\ I_E=0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-10mA,\ I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V,\ I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V,\ I_C=-3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE}=-4V,\ I_C=-1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	170	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B2} OUTPUT I_{B1} I_{B2} I_{B1} 10Ω $V_{CC}=-30V$	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f	$-I_{B1}=I_{B2}=0.15A$ DUTY CYCLE≦1%	-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

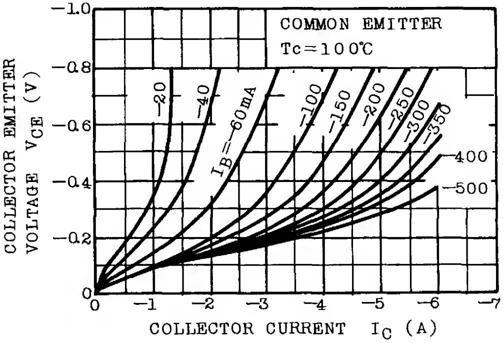
STATIC CHARACTERISTICS



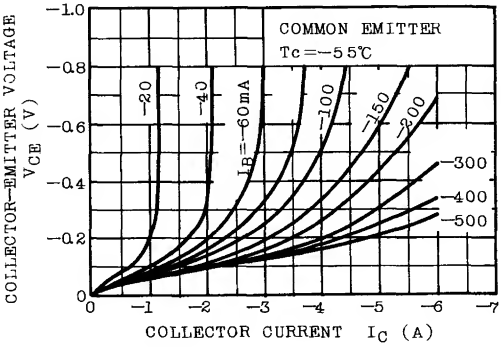
V_{CE} – I_C



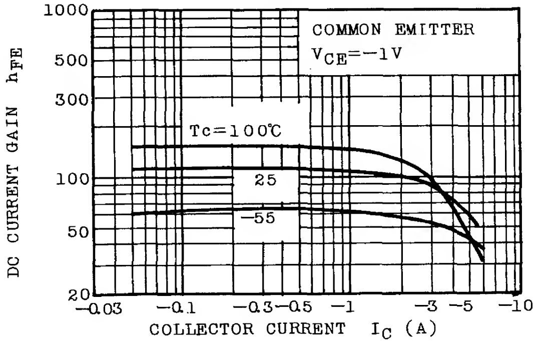
V_{CE} – I_C



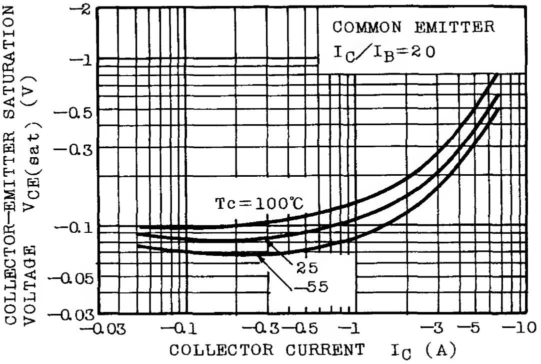
V_{CE} – I_C

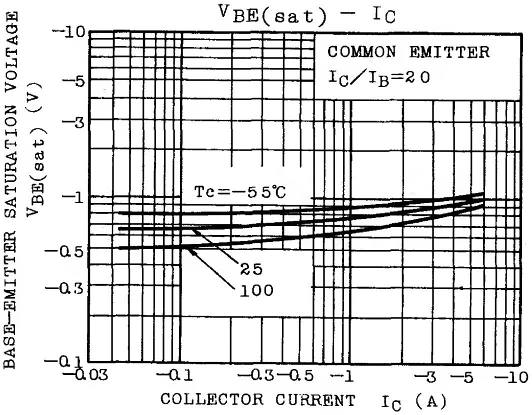


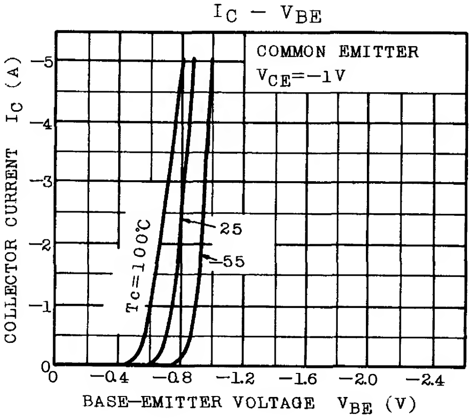
h_{FE} – I_C

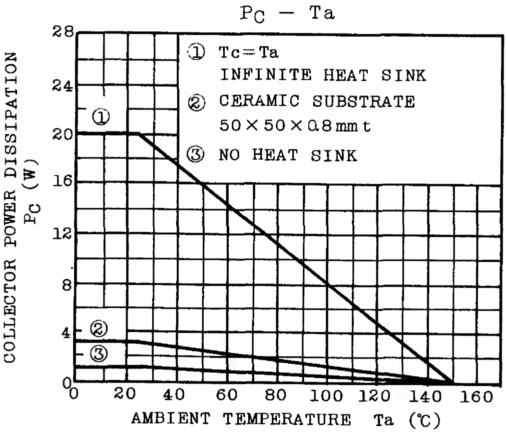


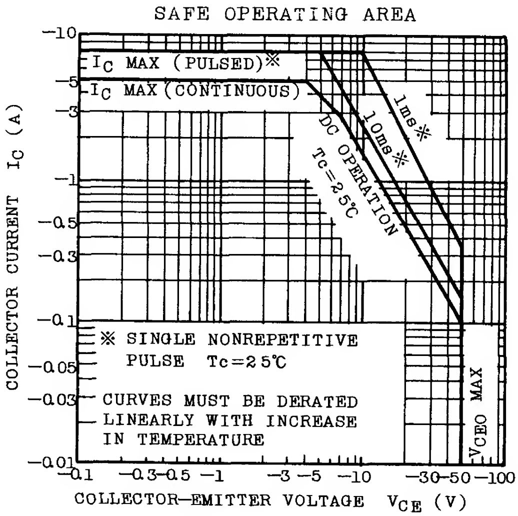
$V_{CE(sat)}$ – I_C




VBE(sat) – IC
COMMON EMITTER
IC/IB=20
Tc=−55°C
25
100
BASE–EMITTER SATURATION VOLTAGE VBE(sat) (V)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.03
−0.1
−0.3
−0.5
−1
−3
−5
−10
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=−1V
Tc=100°C
25
−55
COLLECTOR CURRENT IC (A)
−5
−4
−3
−2
−1
0
0
−0.4
−0.8
−1.2
−1.6
−2.0
−2.4
BASE–EMITTER VOLTAGE VBE (V)


PC – Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
28
24
20
16
12
8
4
0
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE Ta (°C)

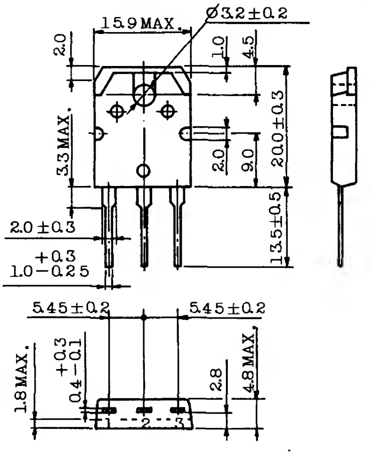

SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION Tc=25°C
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
−0.1
−0.3
−0.5
−1
−3
−5
−10
−30
−50
−100
COLLECTOR–EMITTER VOLTAGE VCE (V)

SILICON PNP TRIPLE DIFFUSED TYPE

2SA1263

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2−16B1A

Weight : 4.6g

FEATURES:

- Complementary to 2SC3180
- Recommend for 40W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

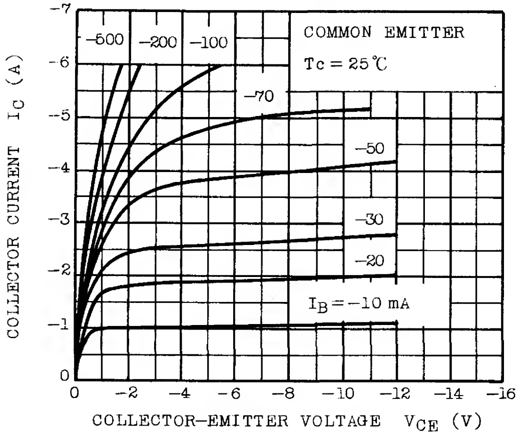
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-6	A
Base Current	I_B	-0.6	A
Collector Power Dissipation (Tc=25°C)	P_C	60	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

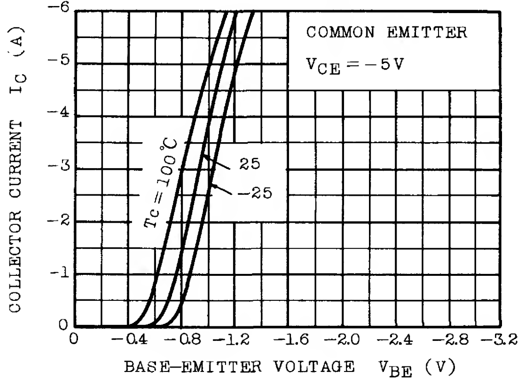
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=80V, I_E=0	-	-	-5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	-
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	35	80	-	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-1.0	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-3A	-	-0.95	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	290	-	pF

Note : $h_{FE(1)}$ Classification R : 55～110 O : 80～160

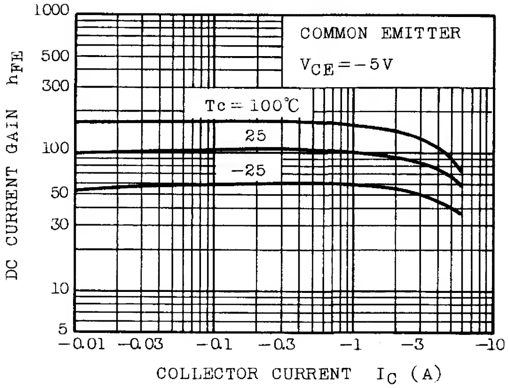
I_C – V_{CE}



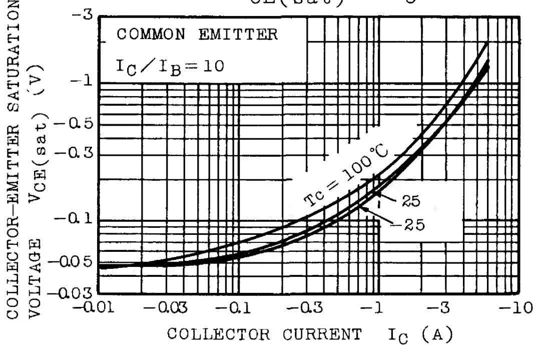
I_C – V_{BE}



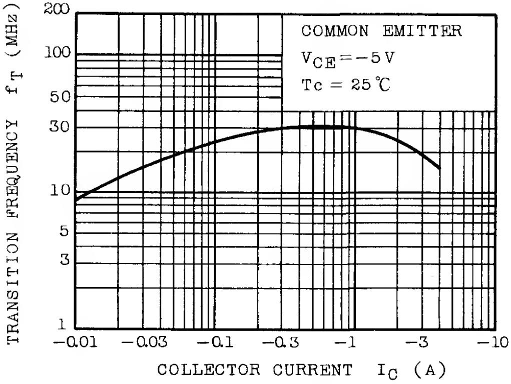
h_{FE} – I_C



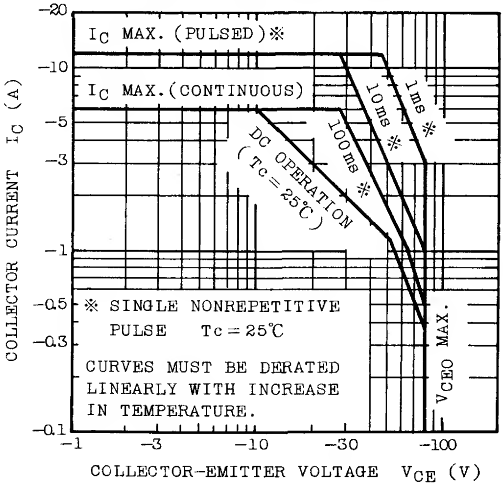
$V_{CE(sat)}$ – I_C



f_T – I_C



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

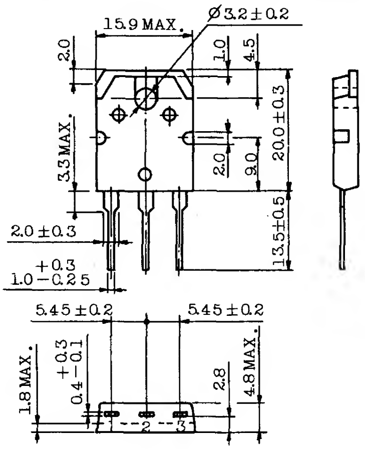
2SA1264

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC3181
- Recommend for 55W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-16B1A

Weight : 4.6g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

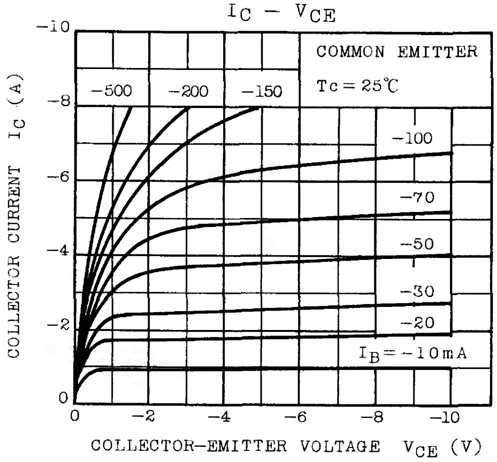
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-120	V
Collector-Emitter Voltage	V_{CEO}	-120	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-8	A
Base Current	I_B	-0.8	A
Collector Power Dissipation ($Tc=25^{\circ}C$)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

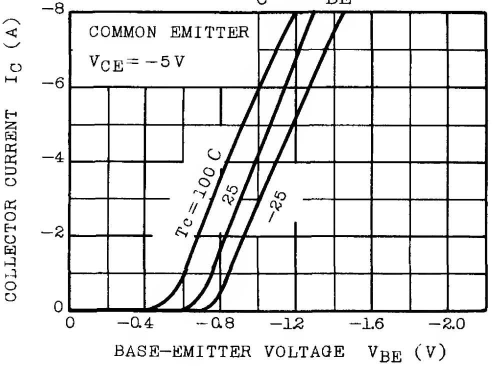
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-120V,\ I_E=0$	-	-	-5.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-50mA,\ I_B=0$	-120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5V,\ I_C=-1A$	55	-	160	
	$h_{FE(2)}$	$V_{CE}=-5V,\ I_C=-4A$	35	75	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-6A,\ I_B=-0.6A$	-	-0.80	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5V,\ I_C=-4A$	-	-0.97	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5V,\ I_C=-1A$	-	30	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	420	-	pF

Note : $h_{FE(1)}$ Classification R : 55 ~ 110 O : 80 ~ 160

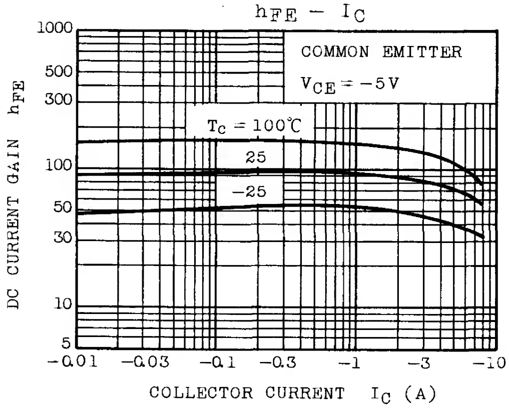
IC – VCE



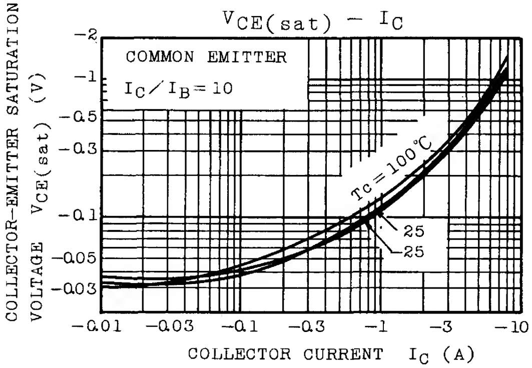
IC – VBE



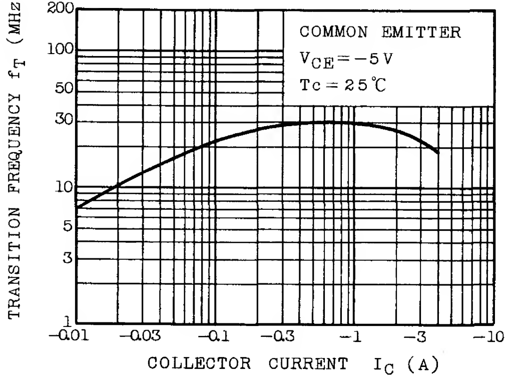
hFE – IC



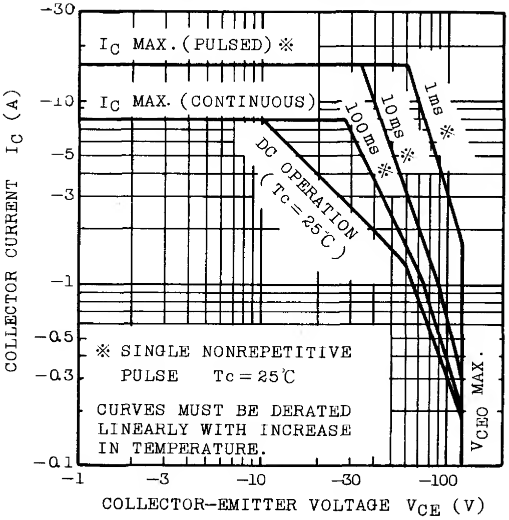
VCE(sat) – IC



fT – IC



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc = 25°C

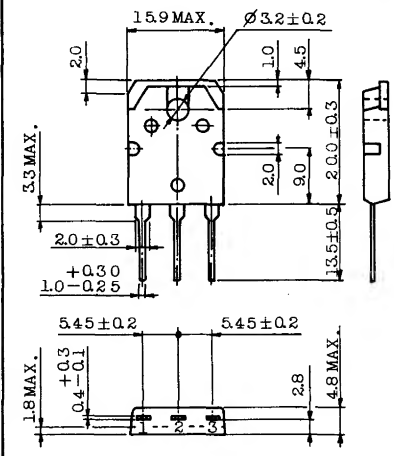
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.

SILICON PNP TRIPLE DIFFUSED TYPE

2SA1265

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

FEATURES:

- Complementary to 2SC3182
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage

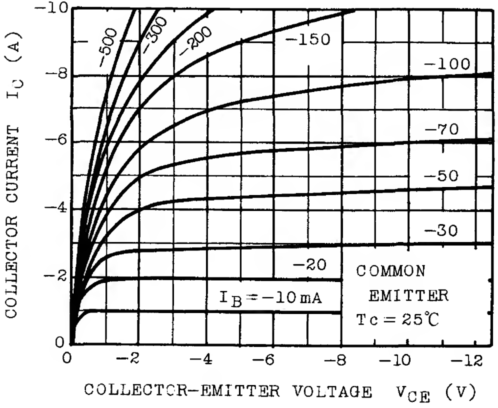
MAXIMUM RATINGS (Ta=25°C)

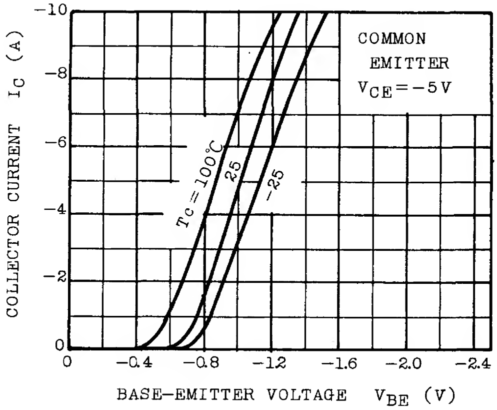
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-140	V
Collector-Emitter Voltage	V_{CEO}	-140	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-10	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

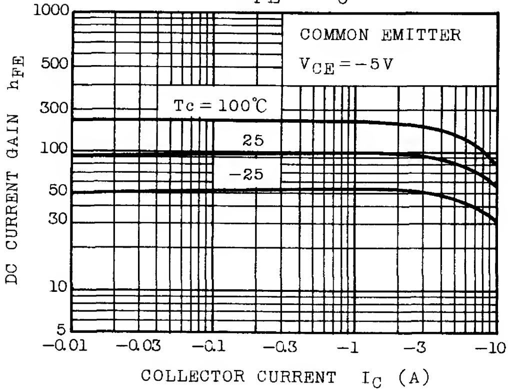
ELECTRICAL CHARACTERISTICS (Ta=25°C)

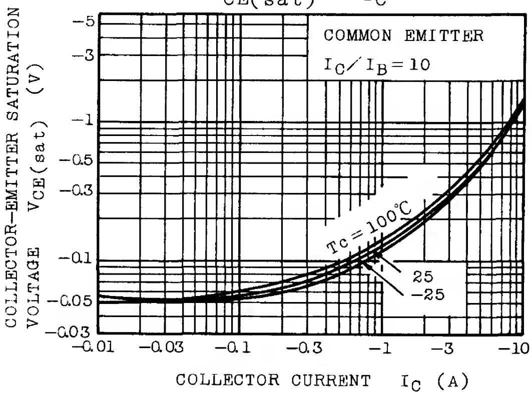
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-140V, I_E=0	-	-	-5.0	µA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	µA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-5A	35	83	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-7A, I_B=-0.7A	-	-0.8	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	480	-	pF

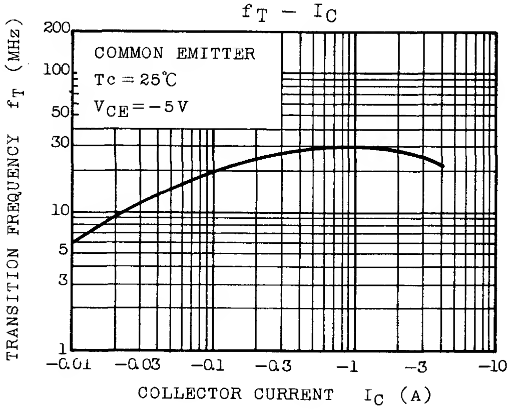
Note : $h_{FE(1)}$ Classification R : 55～110, O : 80～160


I_C – V_{CE}

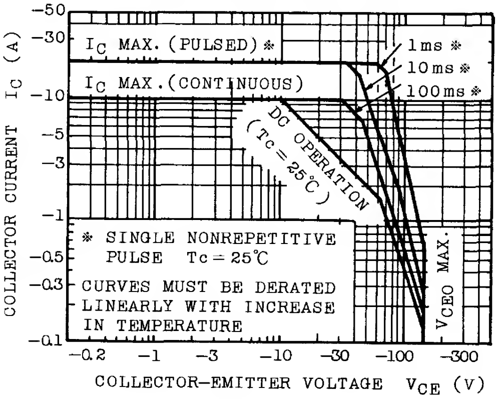

I_C – V_{BE}


h_{FE} – I_C


$V_{CE(sat)}$ – I_C


f_T – I_C

SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc = 25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

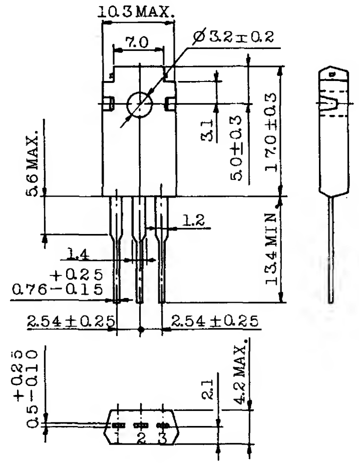
2SA1279

HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.4V(Max.) (at I_C=-3A)
- High Speed Switching Time : t_{stg}=1.0μs(Typ.)
- Complementary to 2SC3239



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

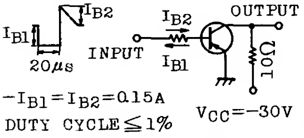
JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

Weight : 2.0g

MAXIMUM RATINGS (T_a=25°C)

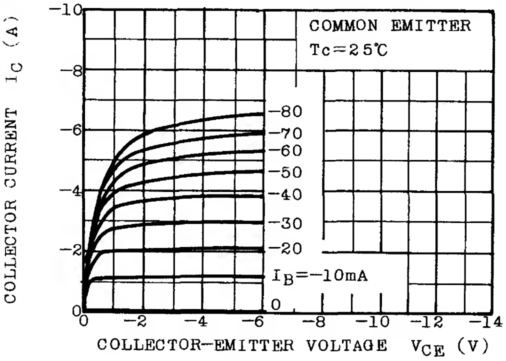
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-1	A
Collector Power Dissipation (T_c=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

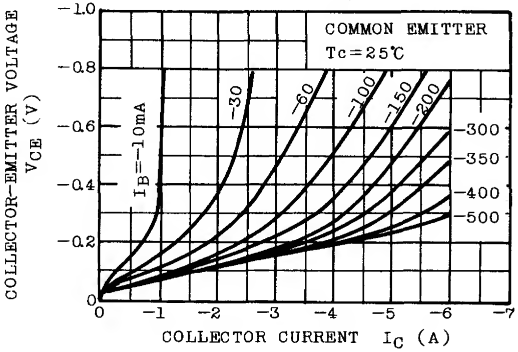
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-50V, I_E=0	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=-3A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-3A, I_B=-0.15A	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-3A, I_B=-0.15A	-	-0.9	-1.2	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	60	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	170	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

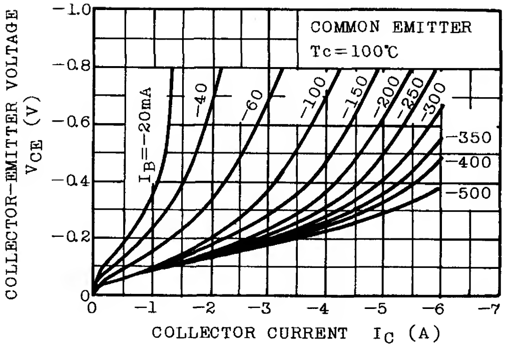
I_C – V_{CE}



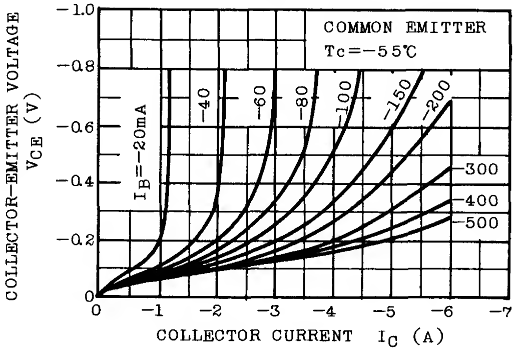
V_{CE} – I_C



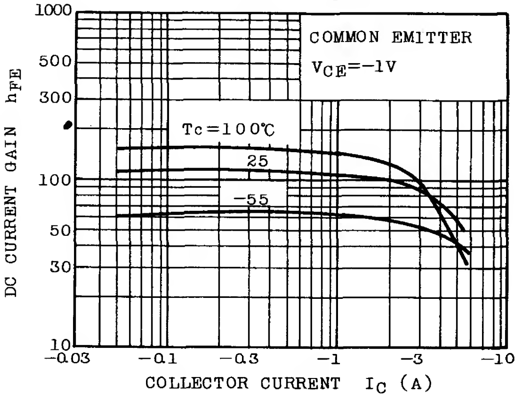
V_{CE} – I_C



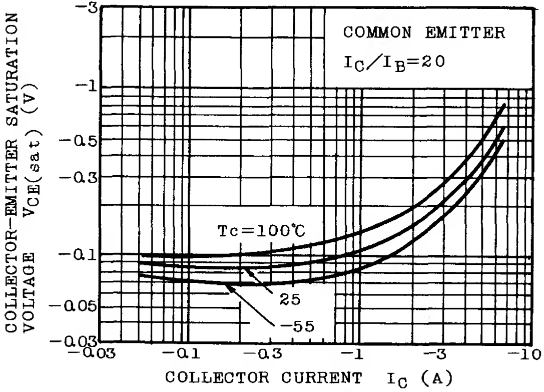
V_{CE} – I_C

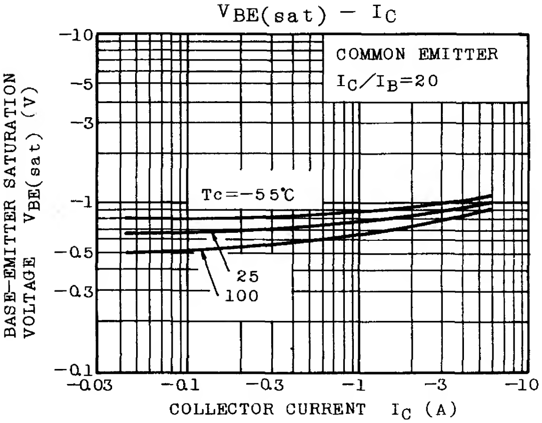


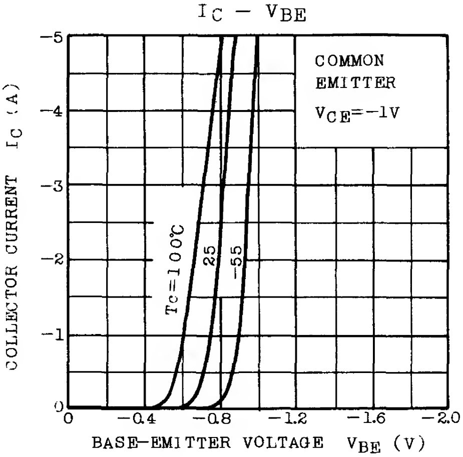
h_{FE} – I_C

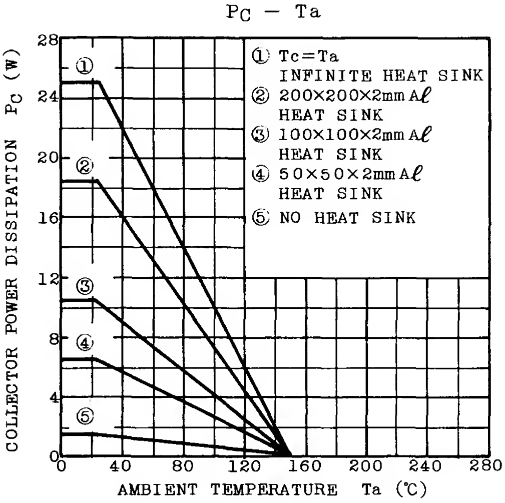


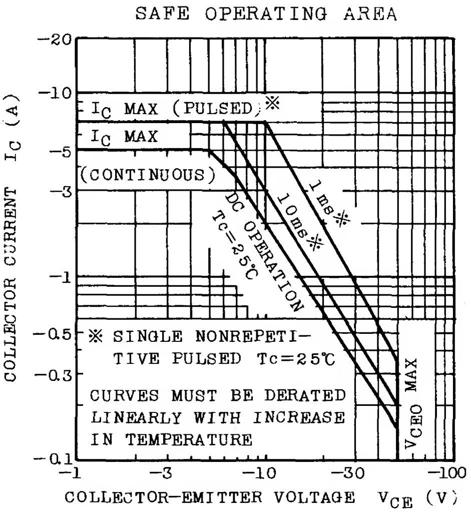
$V_{CE(sat)}$ – I_C




VBE(sat) – IC
COMMON EMITTER
IC/IB=20
Tc=–55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
–10
–5
–3
–1
–0.5
–0.3
–0.1
–0.03
–0.1
–0.3
–1
–3
–10
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=–1V
Tc=100℃
25
–55
COLLECTOR CURRENT IC (A)
–5
–4
–3
–2
–1
0
0
–0.4
–0.8
–1.2
–1.6
–2.0
BASE-EMITTER VOLTAGE VBE (V)


PC – Ta
① Tc=Ta INFINITE HEAT SINK
② 200×200×2mm Aℓ HEAT SINK
③ 100×100×2mm Aℓ HEAT SINK
④ 50×50×2mm Aℓ HEAT SINK
⑤ NO HEAT SINK
①
②
③
④
⑤
COLLECTOR POWER DISSIPATION PC (W)
28
24
20
16
12
8
4
0
0
40
80
120
160
200
240
280
AMBIENT TEMPERATURE Ta (℃)

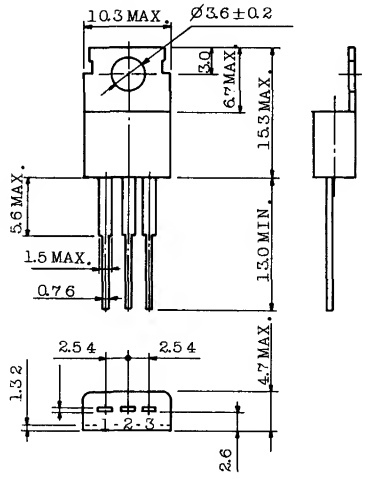

SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1 ms※
10ms※
DC OPERATION Tc=25℃
※ SINGLE NONREPETITIVE PULSED Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
–20
–10
–5
–3
–1
–0.5
–0.3
–0.1
–1
–3
–10
–30
–100
COLLECTOR-EMITTER VOLTAGE VCE (V)

2SA1293

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75
Weight : 1.9g

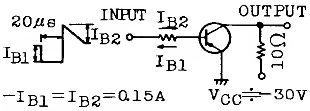
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.4V(Max.)$ at $I_C=-3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)
- Complementary to 2SC3258.

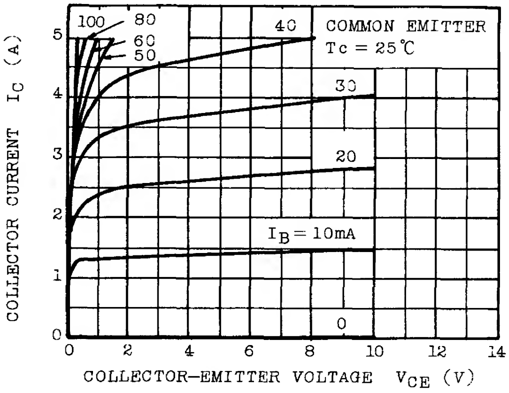
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current	DC	I_C	-5	A
	Pulse	I_{CP}	-8	
Collector Power Dissipation (Tc=25°C)		P_C	30	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

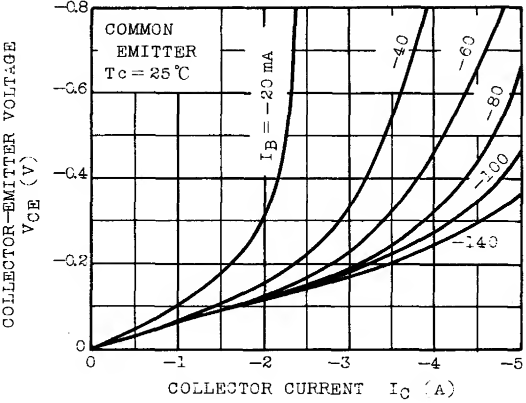
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-100V,\ I_E=0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-7V,\ I_C=0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-10mA,\ I_B=0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V,\ I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V,\ I_C=-3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-3A,\ I_B=-0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE}=-4V,\ I_C=-1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	200	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B2} I_{B2} I_{B1} I_{B1} OUTPUT 10Ω V_{CC} $-I_{B1}=I_{B2}=0.15A$ $V_{CC}=-30V$ DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

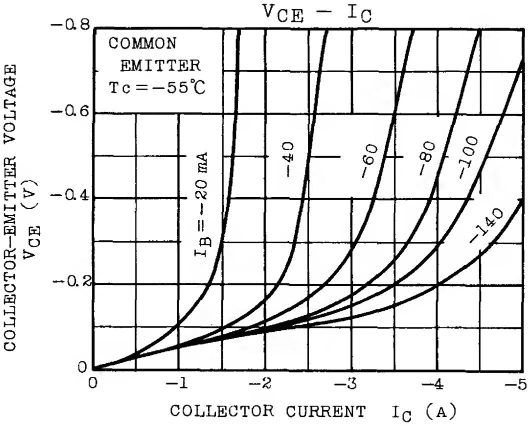
Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240



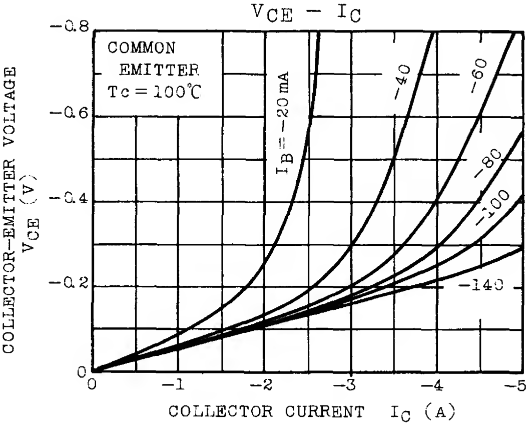
$I_C - V_{CE}$



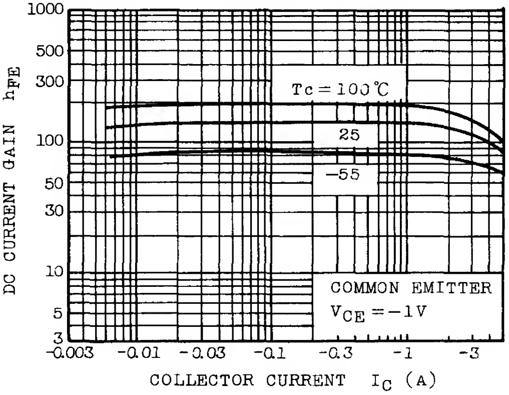
$V_{CE} - I_C$



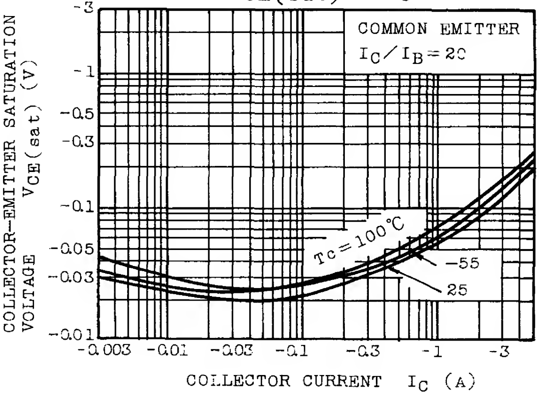
$V_{CE} - I_C$



$V_{CE} - I_C$

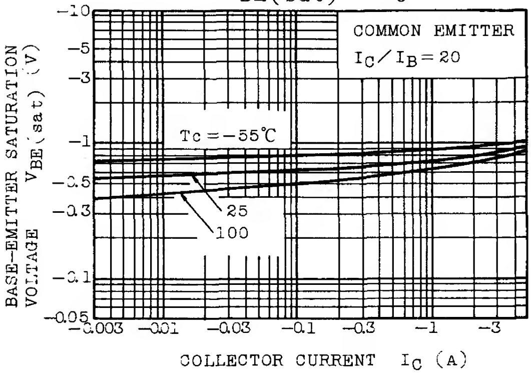


$h_{FE} - I_C$

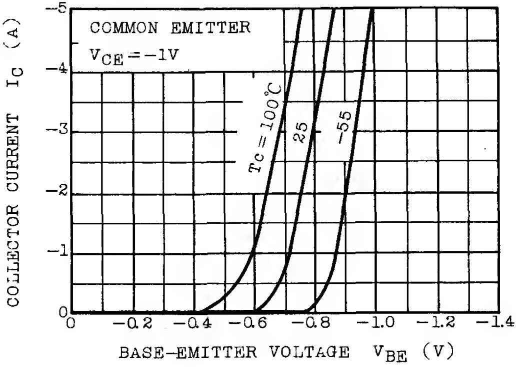


$V_{CE(sat)} - I_C$

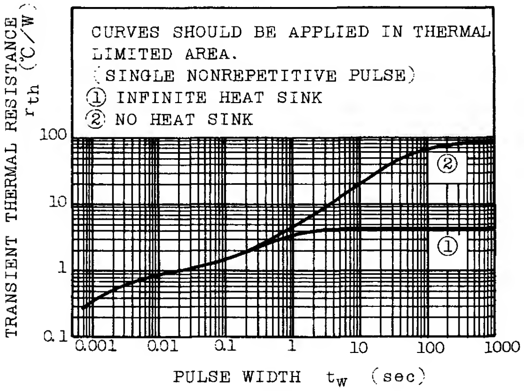
$V_{BE(sat)}$ – I_C



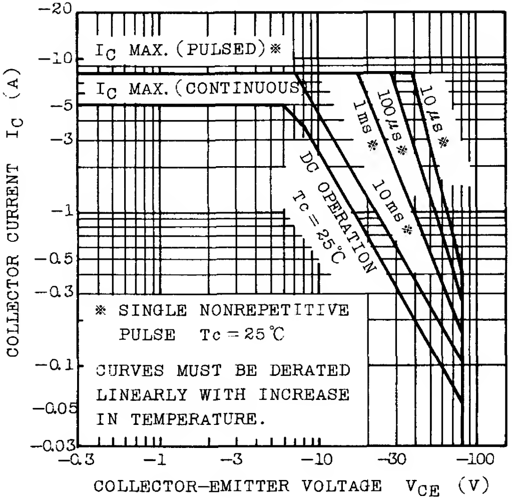
I_C – V_{BE}



r_{th} – t_w



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

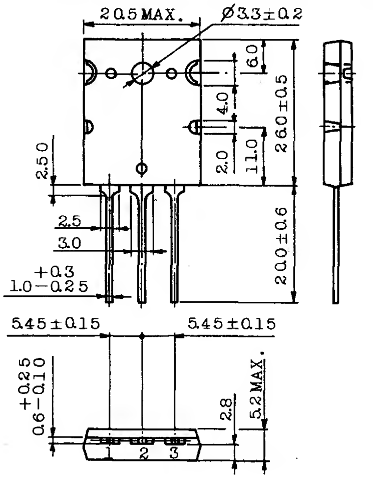
2SA1301

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC3280
- Recommend for 80W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−21F1A

Weight : 9.75g

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-160	V
Collector-Emitter Voltage	V_{CEO}	-160	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-12	A
Base Current	I_B	-1.2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

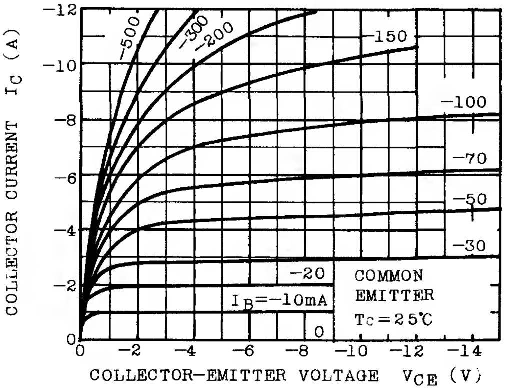
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-160V, I_E=0	-	-	-5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-160	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-6A	35	80	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-8A, I_B=-0.8A	-	-0.9	-2.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-6A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	480	-	pF

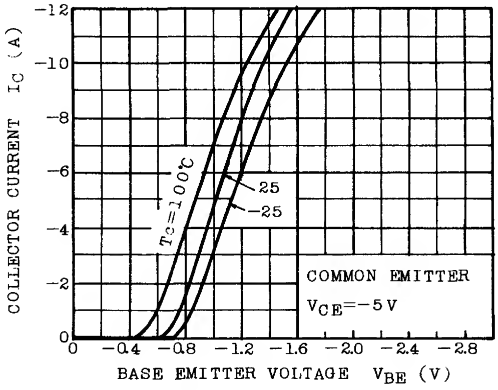
Note : $h_{FE(1)}$ Classification R : 55～110 O : 80～160

2SA1301

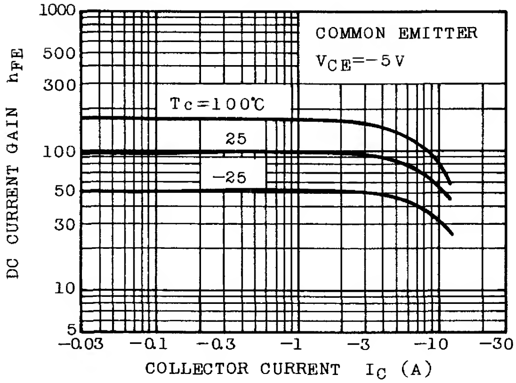
I_C – V_{CE}



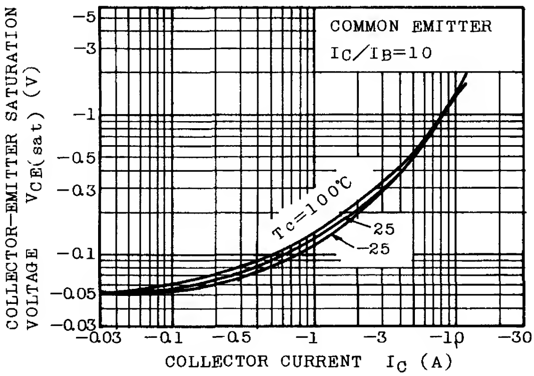
I_C – V_{BE}



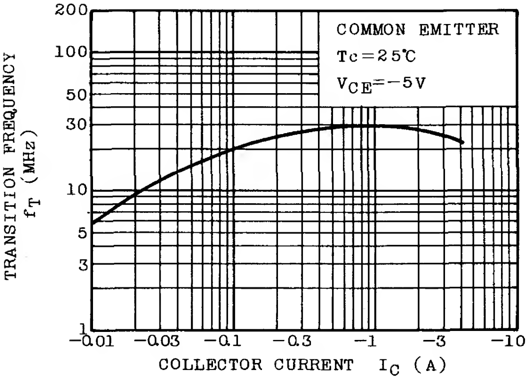
h_{FE} – I_C



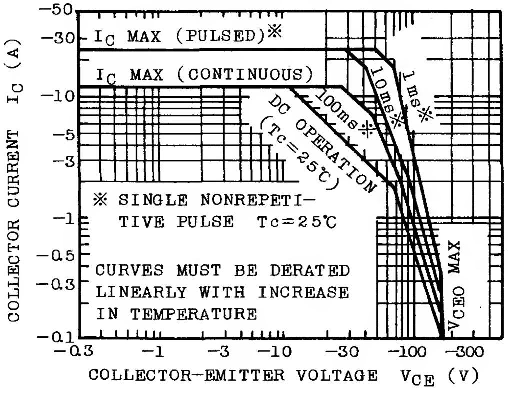
$V_{CE(sat)}$ – I_C



f_T – I_C



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

2SA1302

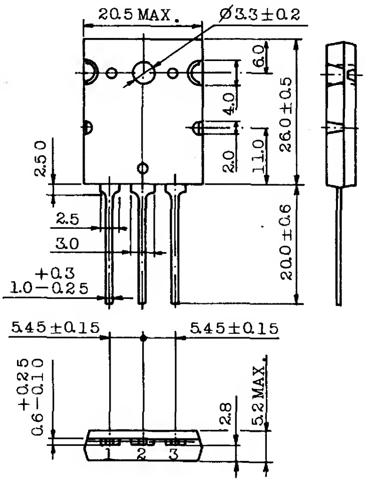
POWER AMPLIFIER APPLICATIONS.

FEATURES:

. Complementary to 2SC3281

. Recommmend for 100W High Fiderity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−21F1A

Weight : 9.75g

MAXIMUM RATINGS (Ta=25°C)

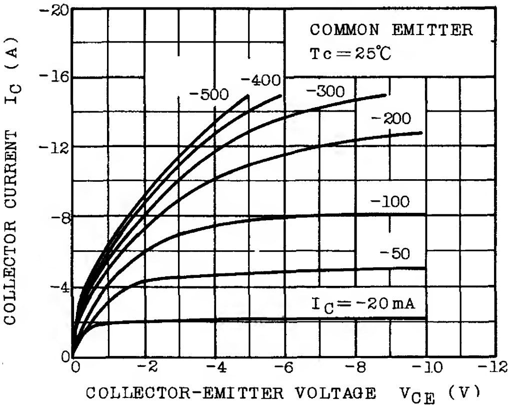
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-200	V
Collector-Emitter Voltage	V_{CEO}	-200	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-15	A
Base Current	I_B	-1.5	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

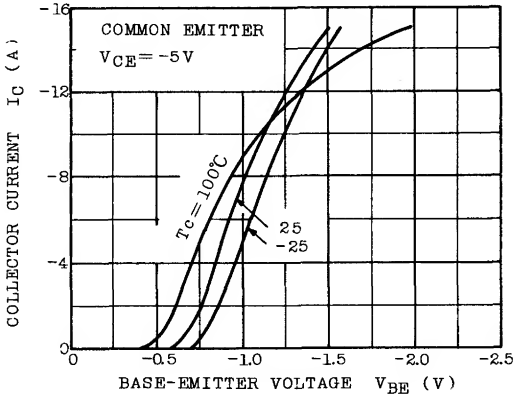
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-200V, I_E=0	-	-	-5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-200	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-8A	35	60	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-10A, I_B=-1A	-	-1.5	-3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-8A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	25	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	470	-	pF

Note : $h_{FE(1)}$ Classification R : 55～110, O : 80～160

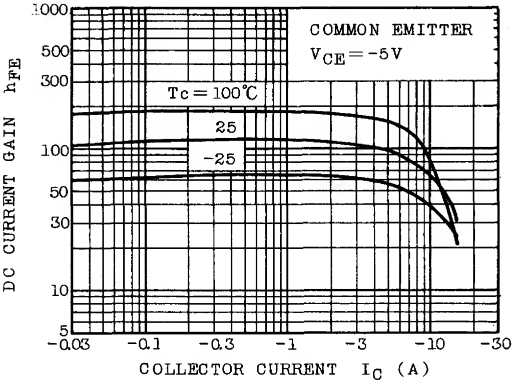
$I_C - V_{CE}$



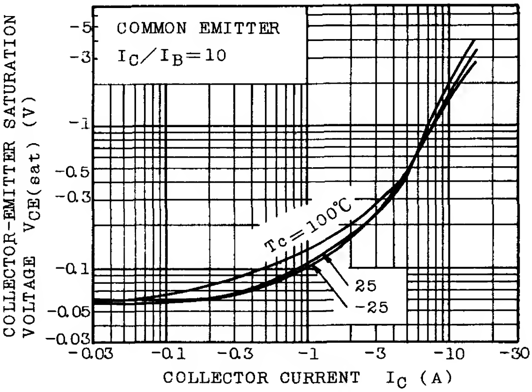
$I_C - V_{BE}$



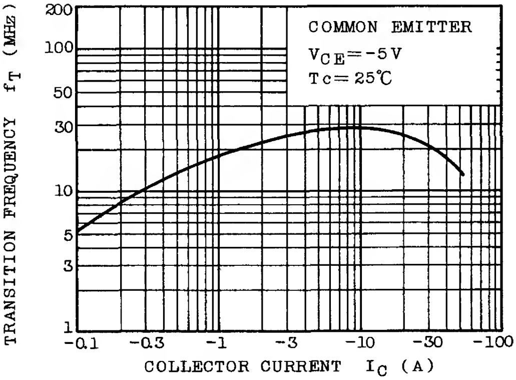
$h_{FE} - I_C$



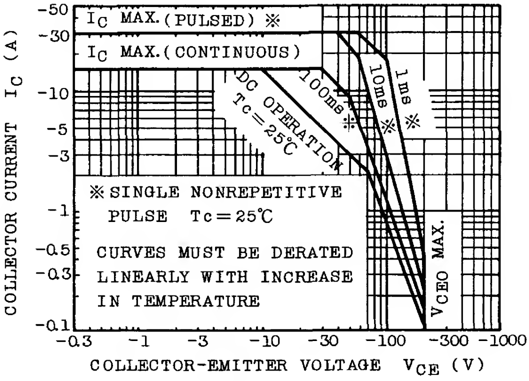
$V_{CE(sat)} - I_C$



$f_T - I_C$



SAFE OPERATING AREA

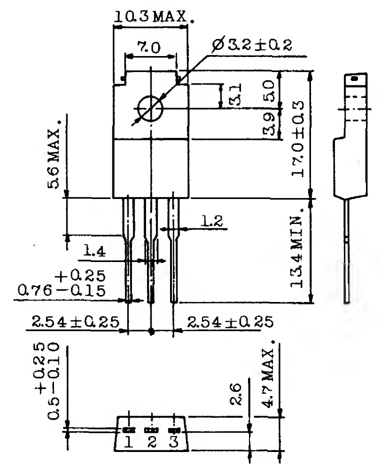


SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1305

POWER AMPLIFIER APPLICATIONS.
CAR RADIO AND CAR STEREO OUTPUT STAGE APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-10L1A

Weight : 2.1g

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SC3297

MAXIMUM RATINGS (Ta=25°C)

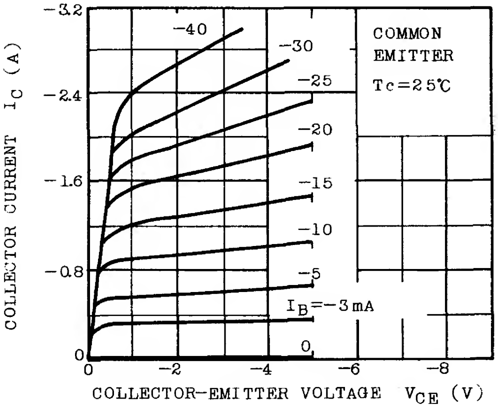
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-30	V
Collector-Emitter Voltage	V_{CEO}	-30	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-0.3	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

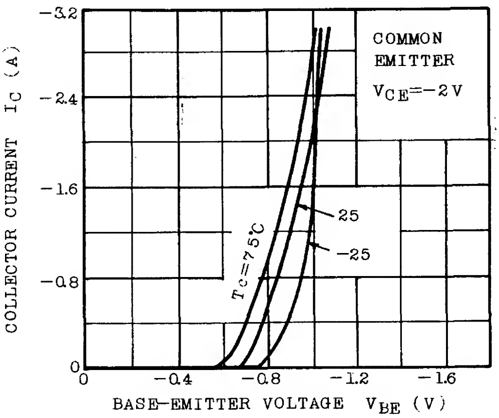
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-20V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-30	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-2V, I_C=-0.5A	70	-	240	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-2.5A	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-2A, I_B=-0.2A	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-0.5A	-	-0.75	-1.0	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	40	-	pF

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

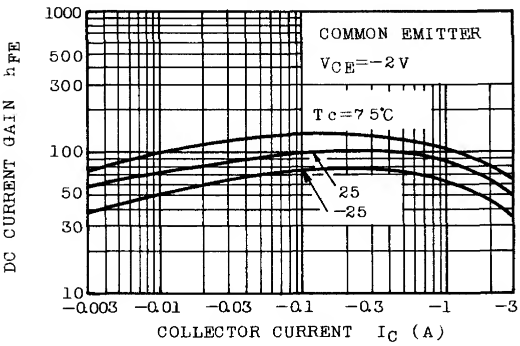
I_C – V_{CE}



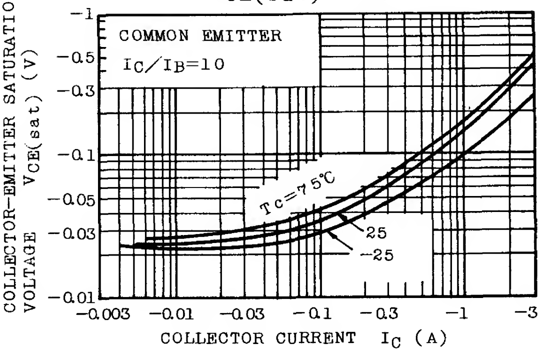
I_C – V_{BE}



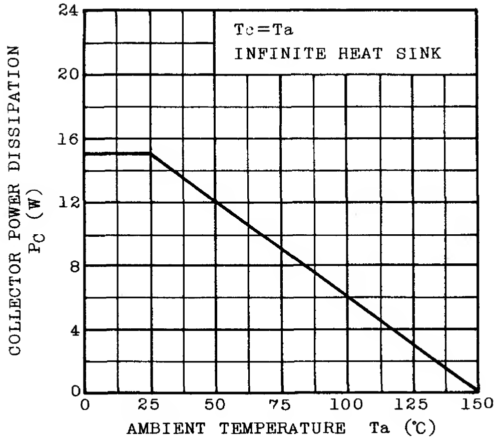
h_{FE} – I_C



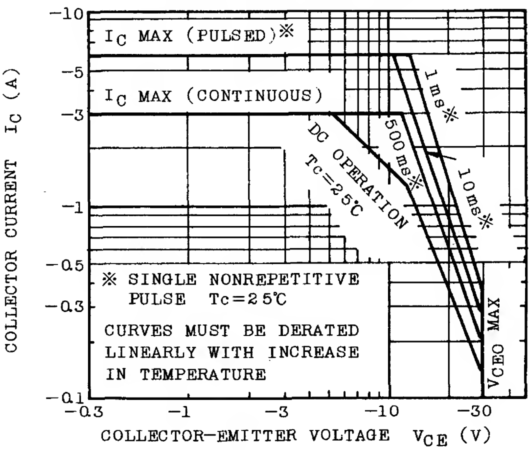
$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

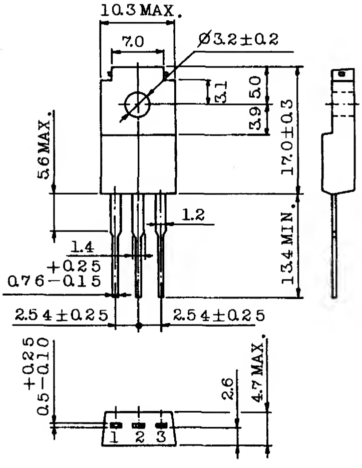
2SA1306
2SA1306A
2SA1306B

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=100MHz (Typ.)
- Complementary to 2SC3298, 2SC3298A, 2SC3298B

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

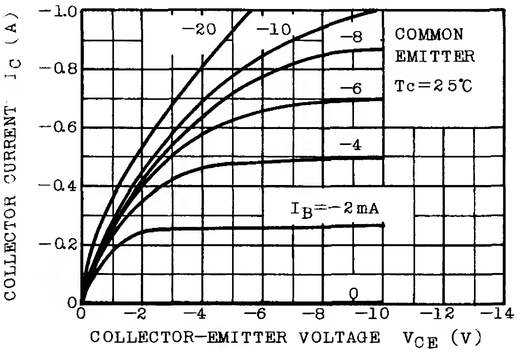
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA1306	V_{CBO}	-160	V
	2SA1306A		-180	
	2SA1306B		-200	
Collector-Emitter Voltage	2SA1306	V_{CEO}	-160	V
	2SA1306A		-180	
	2SA1306B		-200	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-0.15	A
Collector Power Dissipation (Tc=25°C)		P_C	20	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

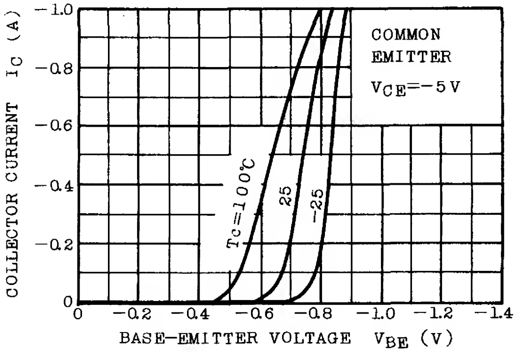
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-160V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	2SA1306	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-160	-	-	V
	2SA1306A			-180	-	-	
	2SA1306B			-200	-	-	
DC Current Gain		h_{FE} (Note)	V_{CE}=-5V, I_C=-100mA	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-1.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-5V, I_C=-500mA	-	-	-1.0	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-100mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_C=0, f=1MHz	-	30	-	pF

Note : h_{FE} Classification O : 70 ~ 140, Y : 120 ~ 240

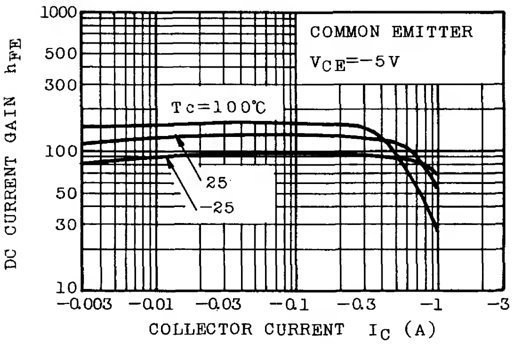
I_C – V_{CE}



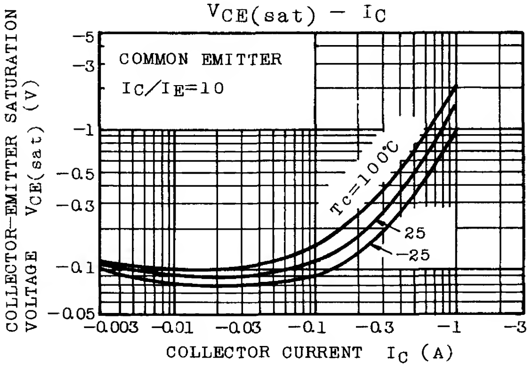
I_C – V_{BE}



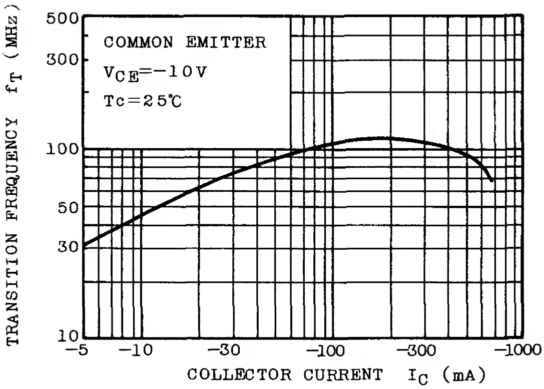
h_{FE} – I_C



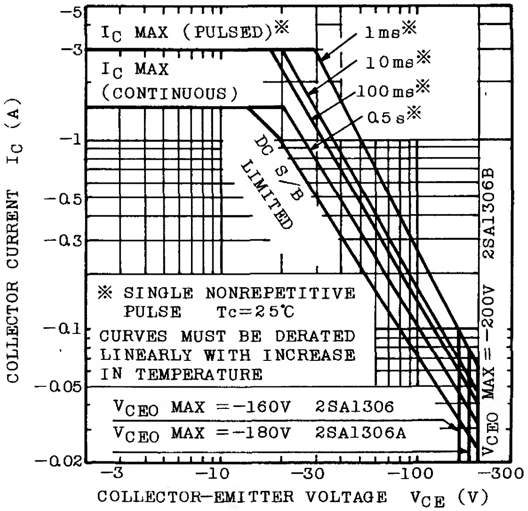
$V_{CE(sat)}$ – I_C



f_T – I_C



SAFE OPERATING AREA



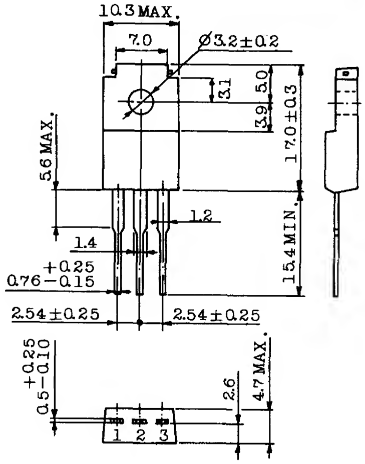
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1307

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Saturation Voltage
  : $V_{CE(sat)}=-0.4V$(Max.) at $I_C=-3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)
- Complementary to 2SC3299



1. BASE
2. COLLECTOR
3. EMITTER

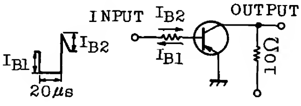
JEDEC	—
EIAJ	—
TOSHIBA	2-10L1A

Weight : 2.1g

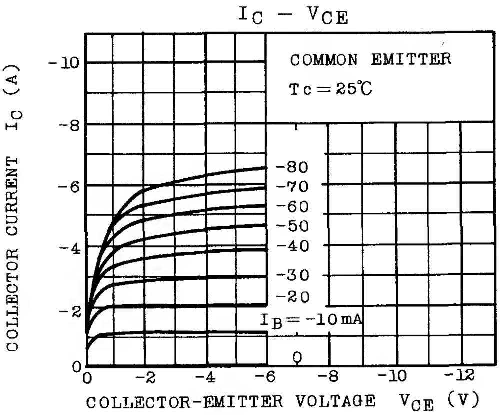
MAXIMUM RATINGS (Ta=25°C)

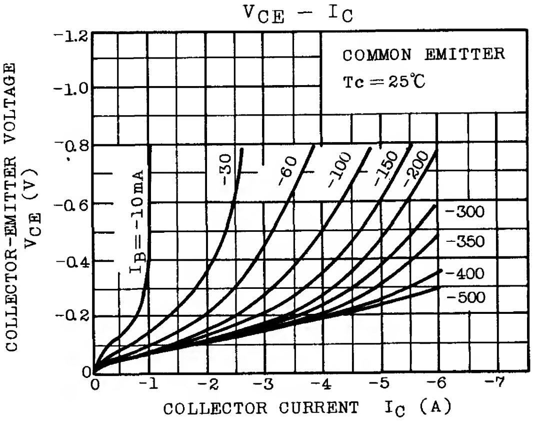
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-5	A
Base Current		I_B	-1	A
Collector Power	Ta=25°C	P_C	2.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

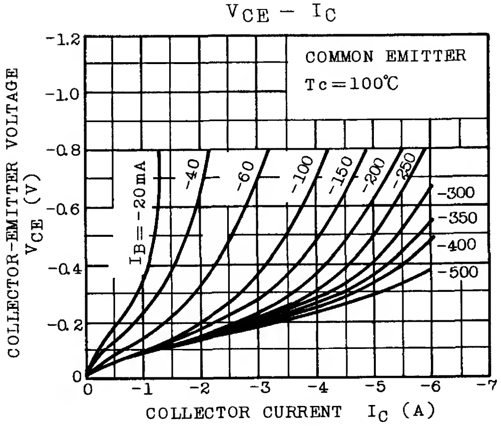
ELECTRICAL CHARACTERISTICS (Ta=25°C)

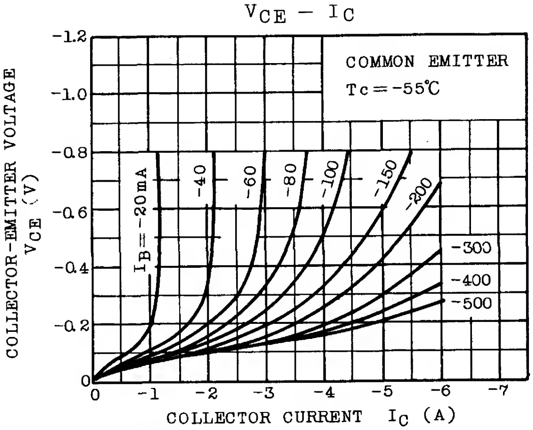
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-50V$, $I_E=0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-10mA$, $I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V$, $I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V$, $I_C=-3A$	30	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-3A$, $I_B=-0.15A$	-	-0.2	-0.4	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-3A$, $I_B=-0.15A$	-	-0.9	-1.2	V
Transition Frequency		f_T	$V_{CE}=-4V$, $I_C=-1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, f=1MHz	-	170	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B2} I_{B1} OUTPUT 10Ω I_{B1} I_{B2} $20\mu s$ $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.15A$ DUTY CYCL≦1%	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

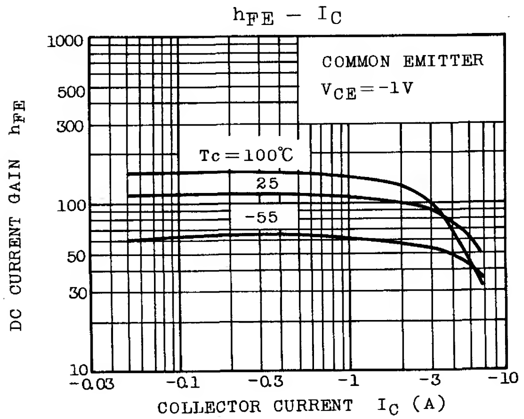
Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

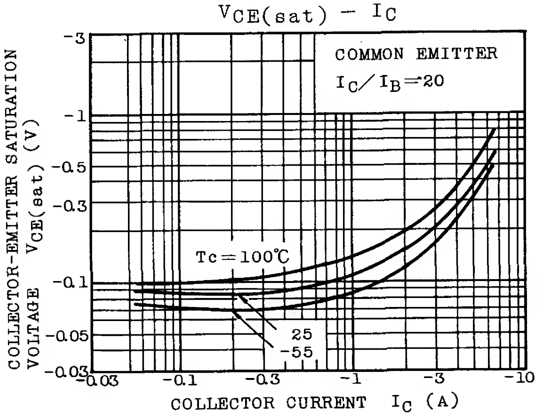

$I_C - V_{CE}$

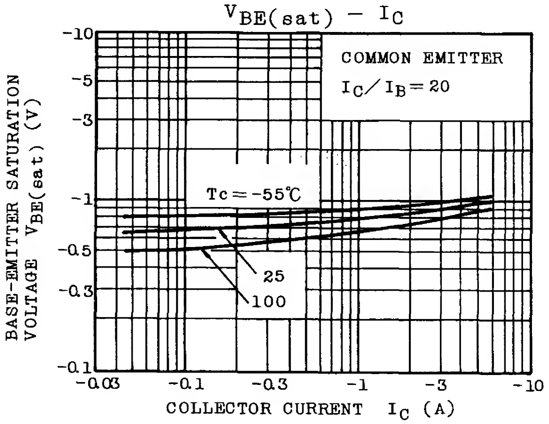

$V_{CE} - I_C$

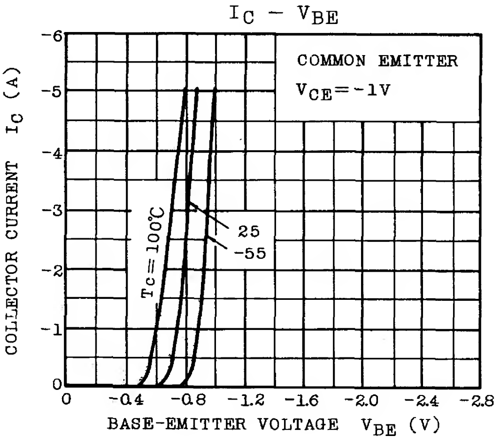

$V_{CE} - I_C$

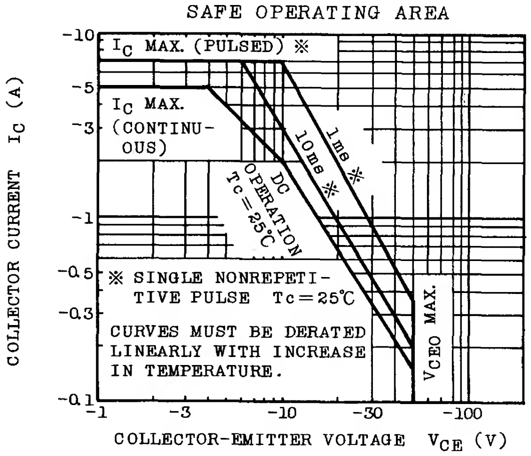

$V_{CE} - I_C$


$h_{FE} - I_C$


$V_{CE(sat)} - I_C$


$V_{BE(sat)}$ – I_C


I_C – V_{BE}

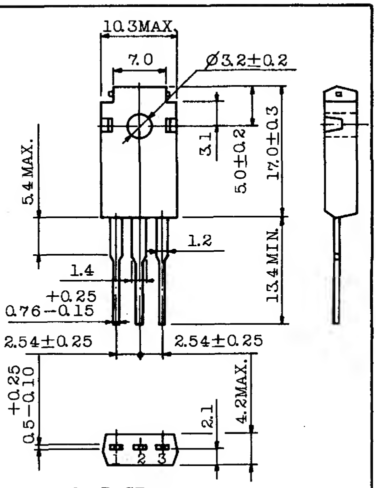

SAFE OPERATING AREA

2SA1308

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-10K1A

Weight : 2.0g

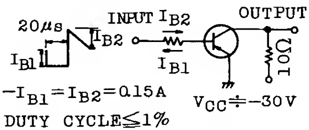
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.4V(Max.) at I_C=-3A
- High Speed Switching Time : t_{stg}=1.0μs(Typ.)
- Complementary to 2SC3308.

MAXIMUM RATINGS (Ta=25°C)

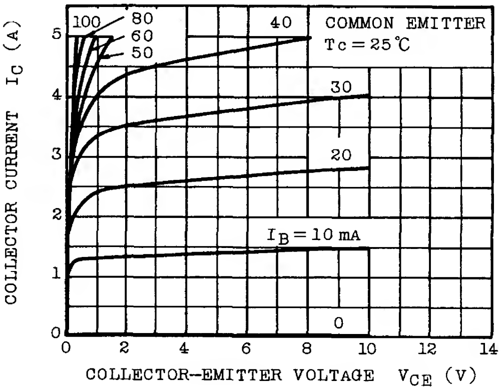
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current	DC	I_C	-5	A
	Pulse	I_{CP}	-8	
Collector Power Dissipation (Tc=25°C)		P_C	30	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

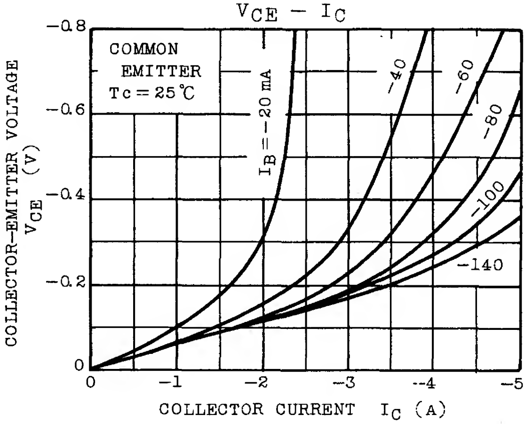
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=-3A	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-3A, I_B=-0.15A	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-3A, I_B=-0.15A	-	-0.9	-1.2	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	60	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	200	-	pF
Switching Time	Turn-on Time	t_{on}	 $-I_{B1}=I_{B2}$=0.15A V_{CC}≒-30V DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

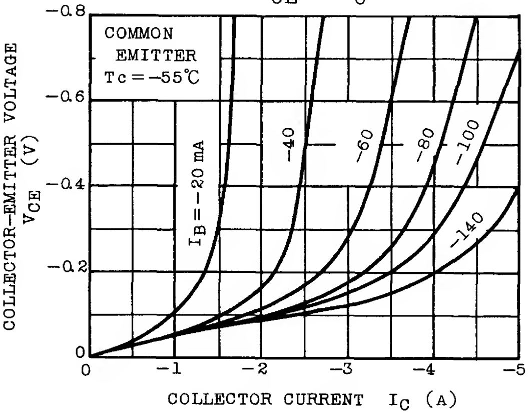
$I_C - V_{CE}$



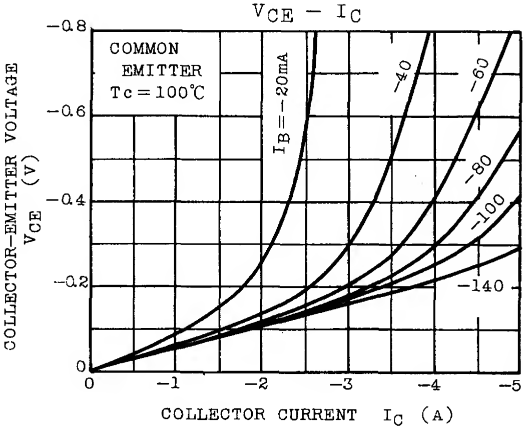
$V_{CE} - I_C$



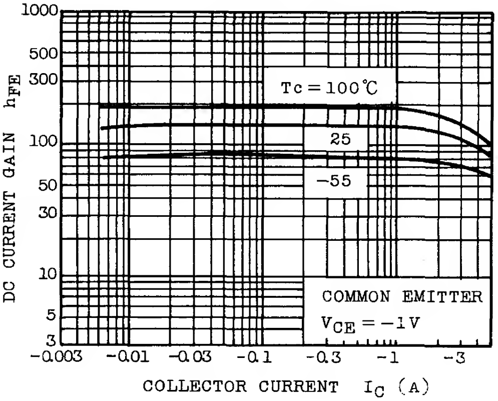
$V_{CE} - I_C$



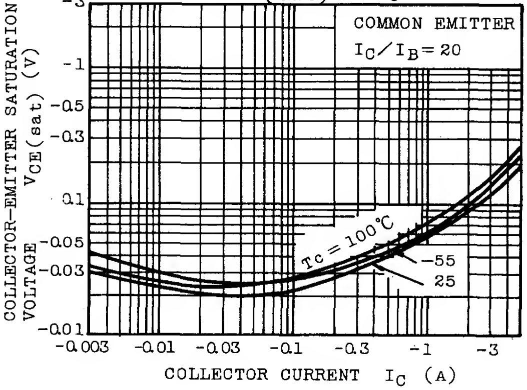
$V_{CE} - I_C$



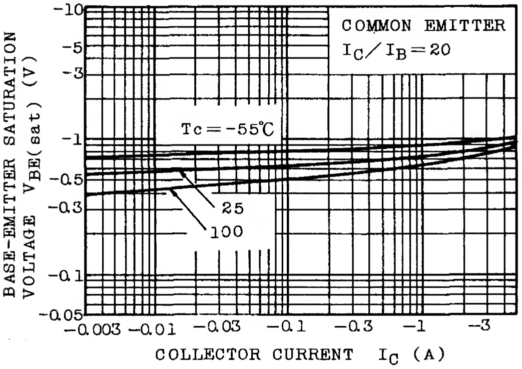
$h_{FE} - I_C$



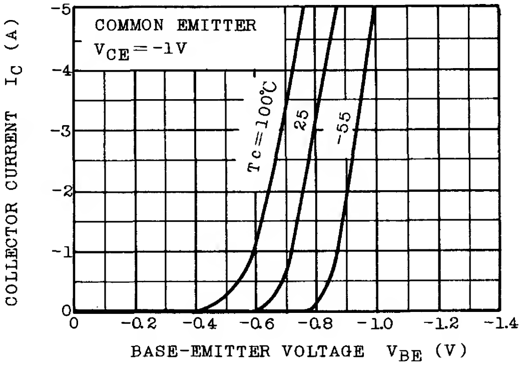
$V_{CE(sat)} - I_C$



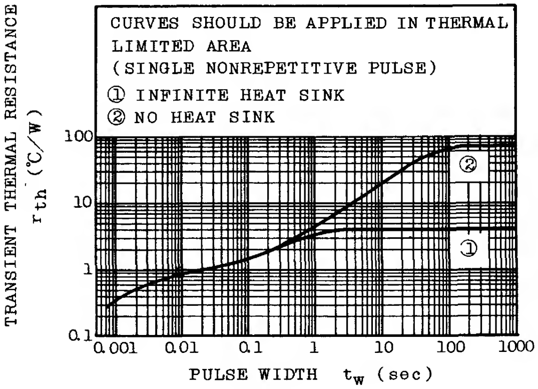
$V_{BE(sat)}$ − I_C



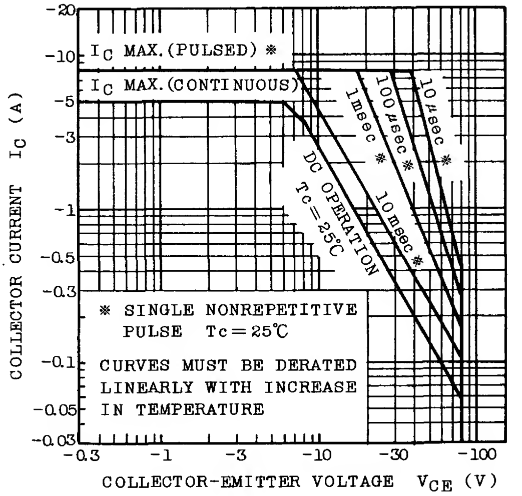
I_C − V_{BE}



r_{th} − t_w



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

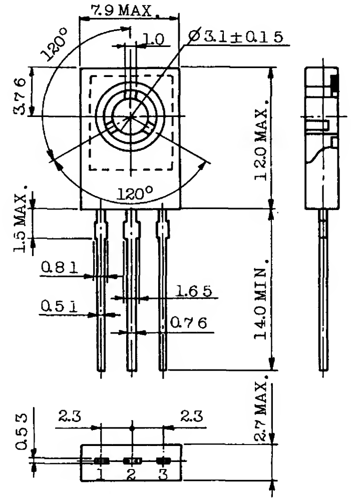
2SA1322

HIGH VOLTAGE SWITCHING APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=-250V
- Low C_{re} : 2.2pF(Max.)
- Complementary to 2SC3335

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

Weight : 0.72g
Mounting Kit No. AC46C

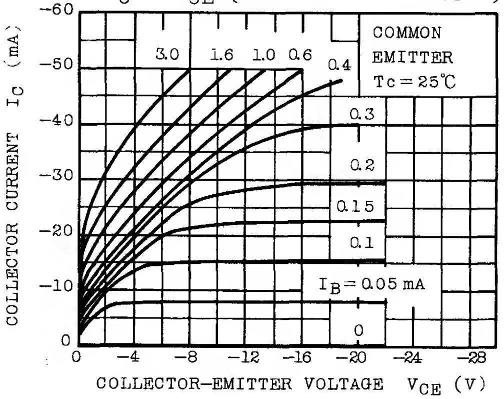
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-250	V
Collector-Emitter Voltage		V_{CEO}	-250	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current	DC	I_C	-50	mA
	Peak	I_{CP}	-100	
Base Current		I_B	-20	mA
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	Tc=25°C		5.0	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

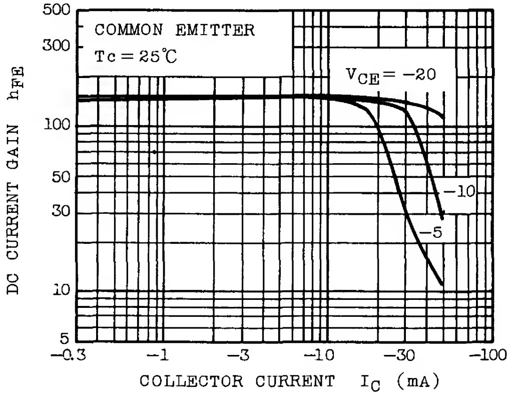
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-200V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-1mA, I_B=0	-250	-	-	V
DC Current Gain	h_{FE}	V_{CE}=-20V, I_C=-25mA	50	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-10mA, I_B=-1mA	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-20V, I_C=-25mA	-	-0.75	-	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-10mA	60	80	-	MHz
Reverse Transfer Capacitance	C_{re}	V_{CB}=-30V, I_E=0, f=1MHz	-	-	2.2	pF

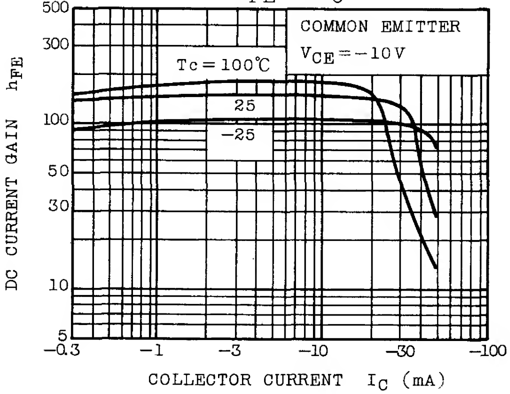
I_C – V_{CE} (LOW VOLTAGE REGION)



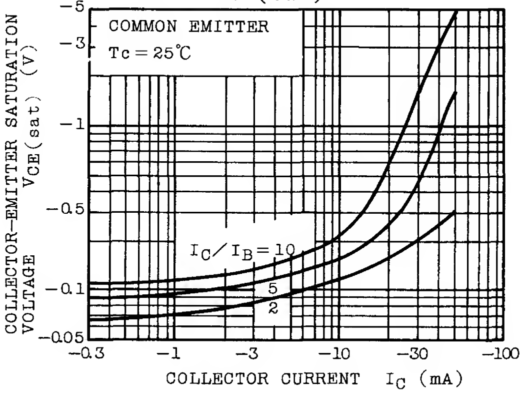
h_{FE} – I_C



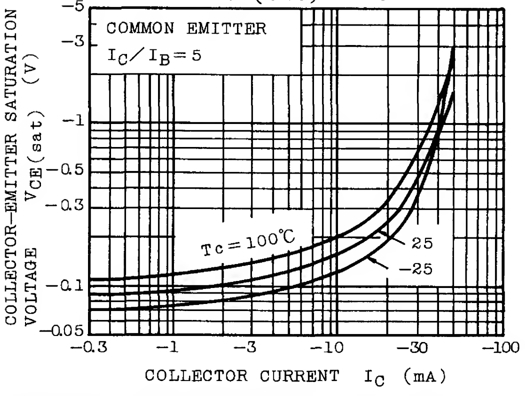
h_{FE} – I_C



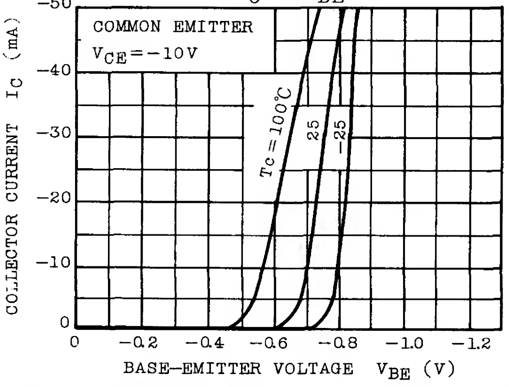
$V_{CE(sat)}$ – I_C

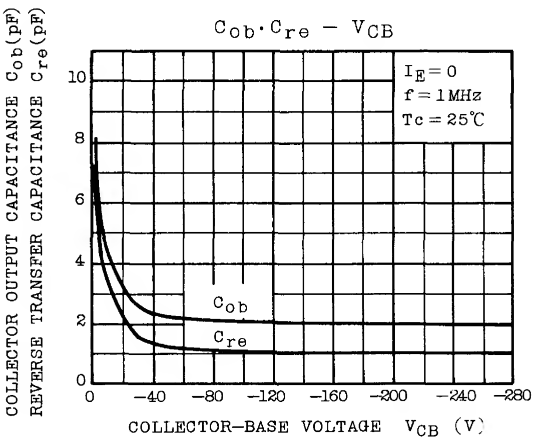


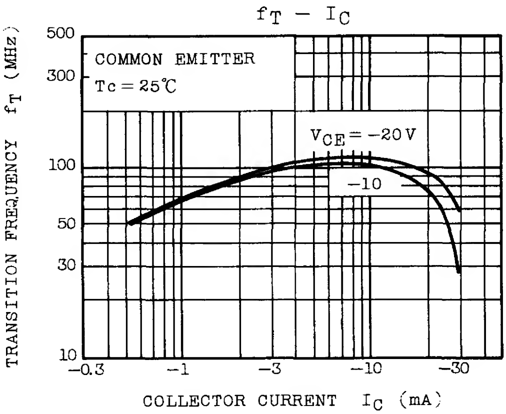
$V_{CE(sat)}$ – I_C

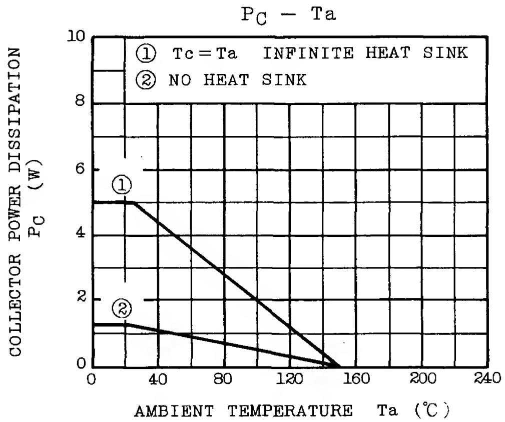


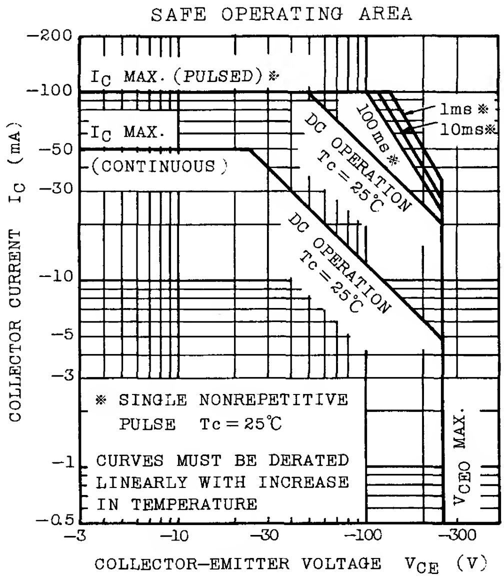
I_C – V_{BE}




$C_{ob} \cdot C_{re}$ — V_{CB}


f_T — I_C


P_C — Ta


SAFE OPERATING AREA

2SA1327

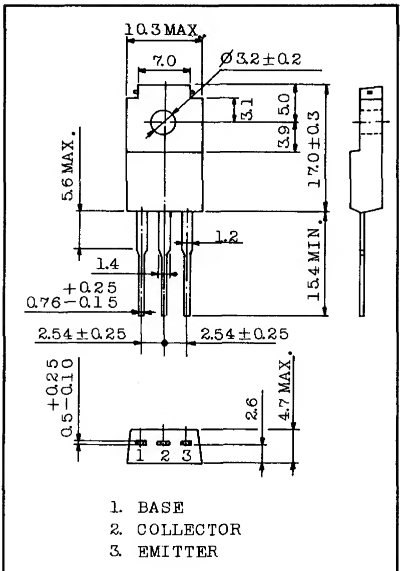
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

STROBO FLASH APPLICATIONS.
AUDIO POWER AMPLIFIER APPLICATIONS.

FEATURES:

- MIN. h_{FE} of 70 at -2V, -8A
- -10A Rated Collector Current
- MAX. $V_{CE(sat)}$ of -0.5V at -8A I_C
- 20W at 25°C Case Temperature

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2–10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

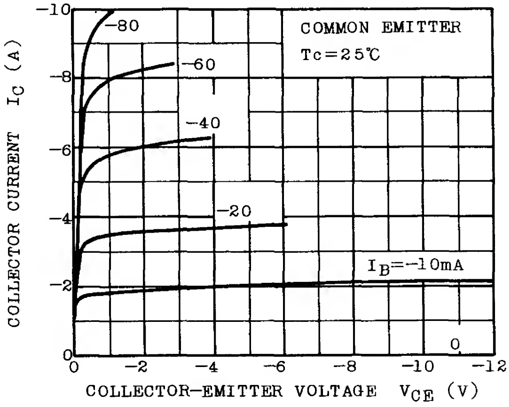
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-50	V
Collector-Emitter Voltage		V_{CEO}	-20	V
Emitter-Base Voltage		V_{EBO}	-8	V
Collector Current	DC	I_C	-10	A
	Pulse	I_{CP}	-20	A
Base Current		I_B	-2	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		20	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

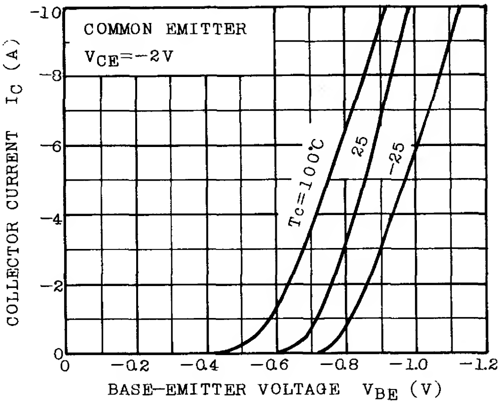
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-50V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-8V, I_C=0	-	-	-1.0	μA
Collector-Emitter Brakdown Voltage	V_{CEO}	I_C=-10mA, I_B=0	-20	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-2V, I_C=-1A	100	-	320	
	$h_{FE(2)}$	V_{CE}=-2V, I_C=-8A	70	140	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-8A, I_B=-0.4A	-	-0.3	-0.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-8A	-	-0.95	-0.5	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-1A	-	45	-	MHz
Collector Output Capacitance	Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	400	-	pF

Note : $h_{FE(1)}$ Classification O : 100～200, Y : 160～320

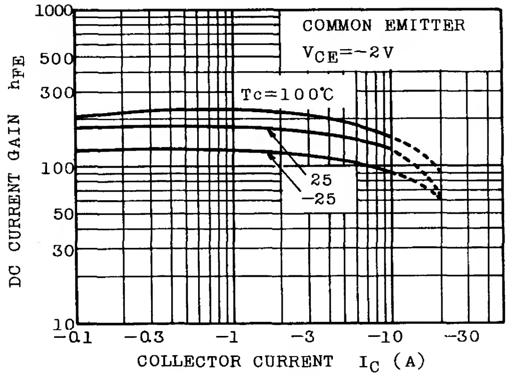
$I_C - V_{CE}$



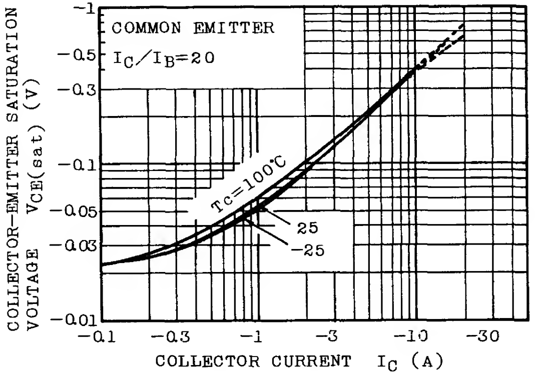
$I_C - V_{BE}$



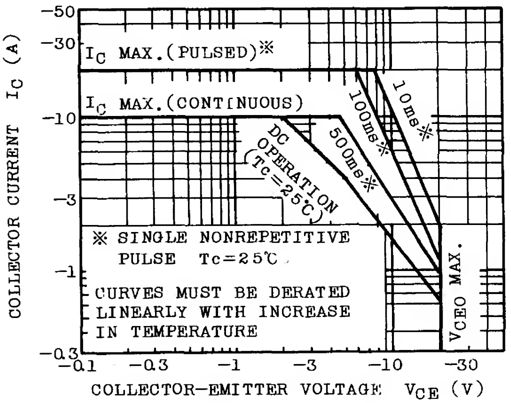
$h_{FE} - I_C$



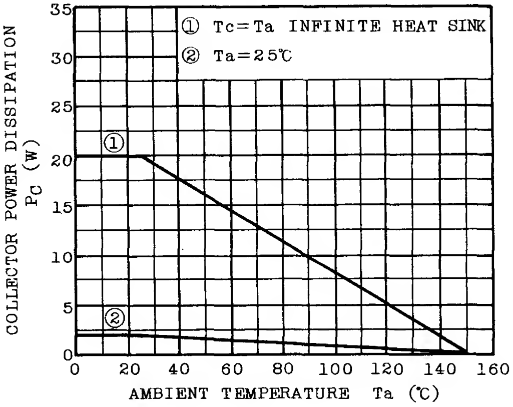
$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



$P_C - Ta$



2SA1328

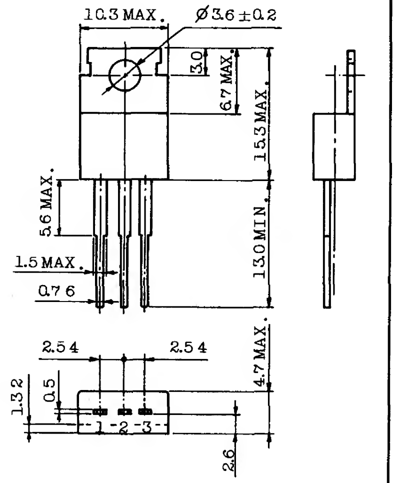
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.4V$(Max.) at $I_C=-6A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)
- Complementary to 2SC3345

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

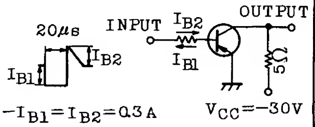
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

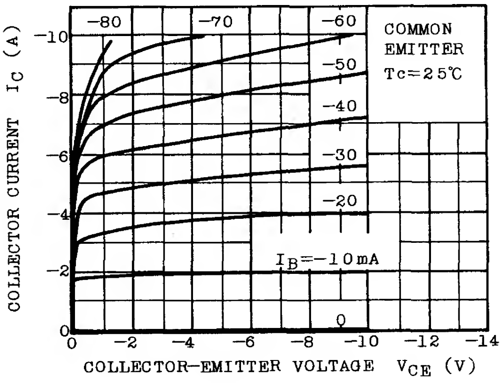
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-6	V
Collector Current	I_C	-12	A
Base Current	I_B	-2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

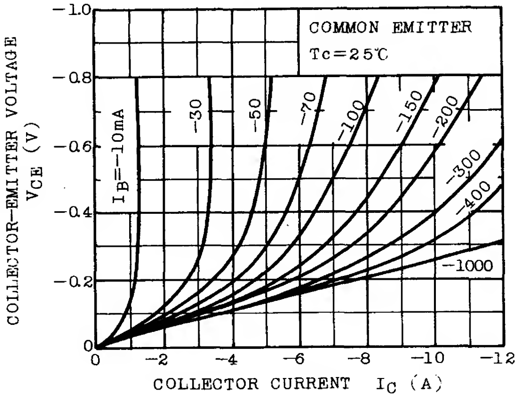
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-60V$, $I_E=0$	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-6V$, $I_C=0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA$, $I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V$, $I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V$, $I_C=-6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-6A$, $I_B=-0.3A$	-	-0.15	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-6A$, $I_B=-0.3A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE}=-5V$, $I_C=-1A$	-	70	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, f=1MHz	-	320	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B2} OUTPUT I_{B1} I_{B2} I_{B1} 5Ω $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.3A$ DUTY CYCLE≦1%	-	0.3	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

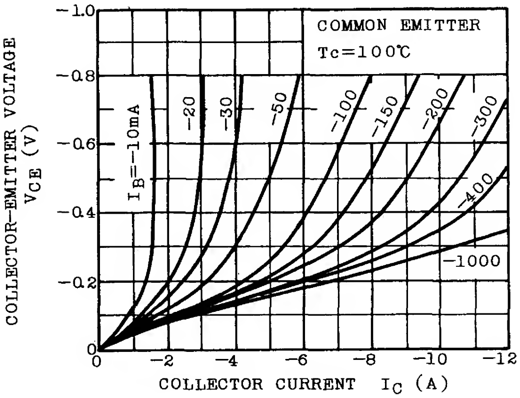
$I_C - V_{CE}$



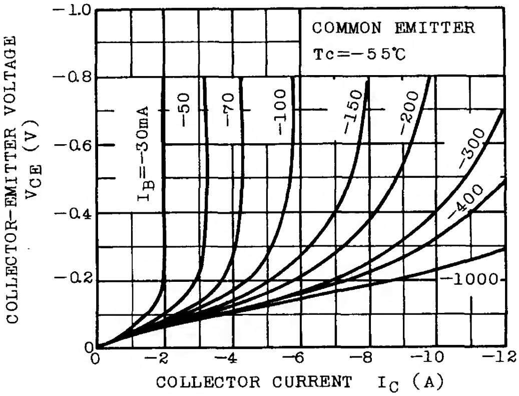
$V_{CE} - I_C$



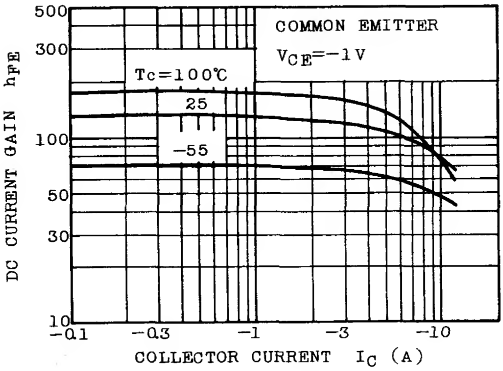
$V_{CE} - I_C$



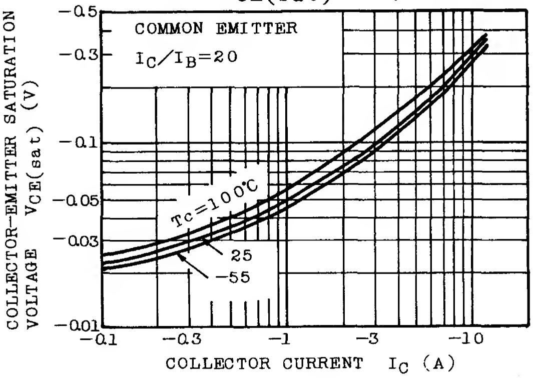
$V_{CE} - I_C$



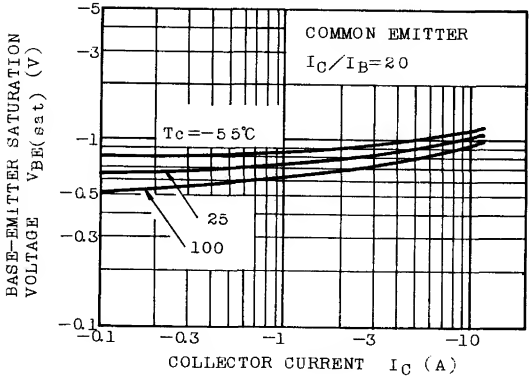
$h_{FE} - I_C$



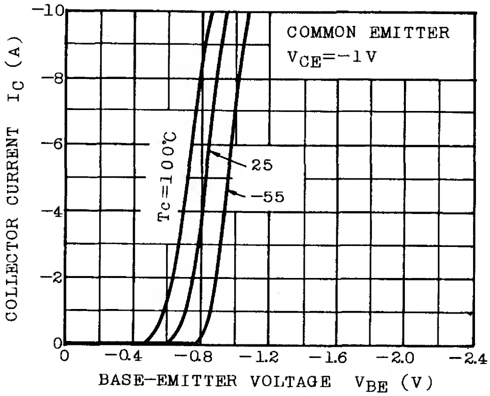
$V_{CE(sat)} - I_C$



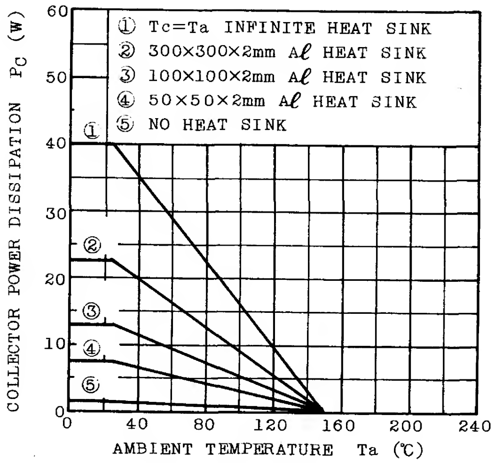
$V_{BE(sat)}$ – I_C



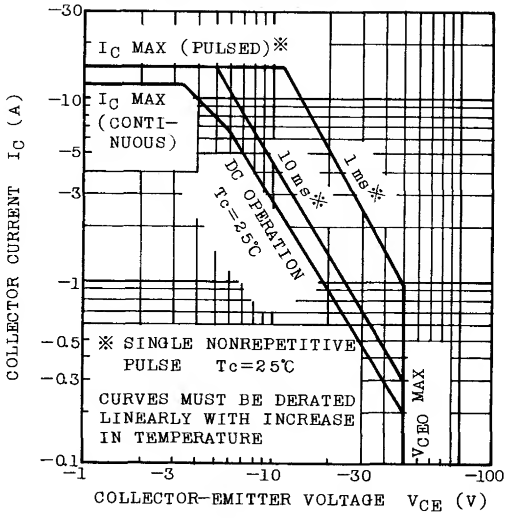
I_C – V_{BE}



P_C – Ta



SAFE OPERATING AREA

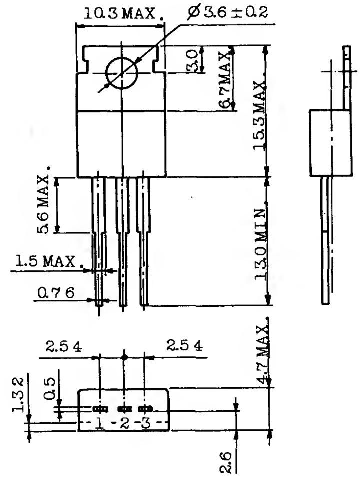


SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA1329

HIGH CURRENT SWITCHING APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

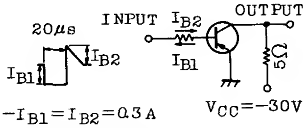
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.4V$(Max.) at $I_C=-6A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)
- Complementary to 2SC3346

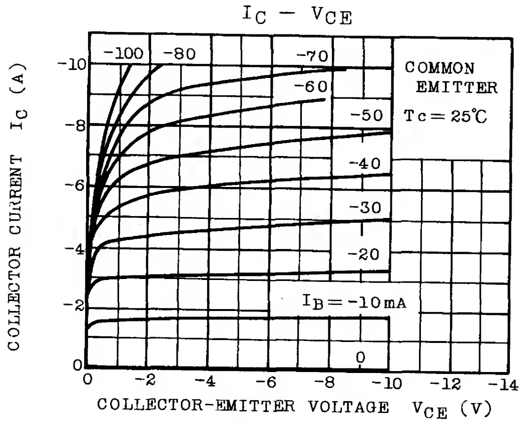
MAXIMUM RATINGS ($Ta=25^\circ C$)

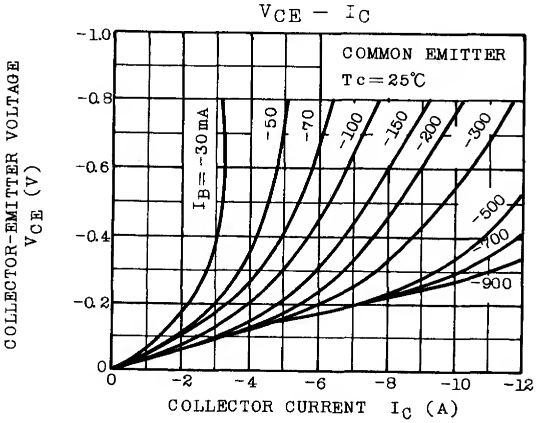
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-6	V
Collector Current	I_C	-12	A
Base Current	I_B	-2	A
Collector Power Dissipation ($Tc=25^\circ C$)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

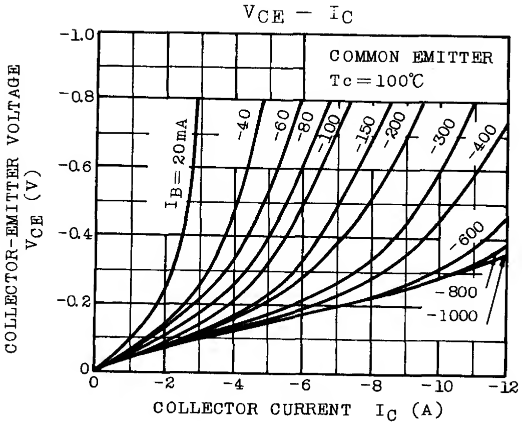
ELECTRICAL CHARACTERISTICS ($Ta=25^\circ C$)

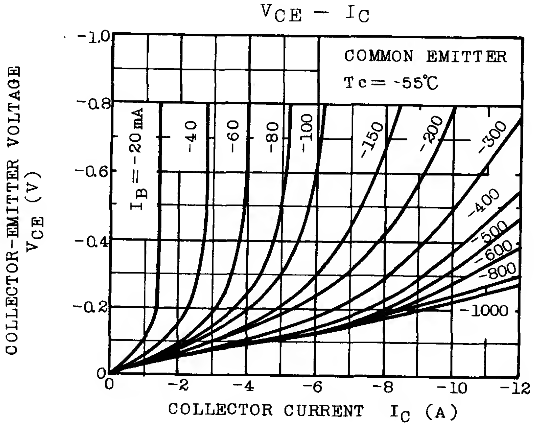
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-80V,\ I_E=0$	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-6V,\ I_C=0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA,\ I_B=0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V,\ I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V,\ I_C=-6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-6A,\ I_B=-0.3A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-6A,\ I_B=-0.3A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE}=-5V,\ I_C=-1A$	-	50	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	400	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B2} OUTPUT I_{B1} I_{B2} I_{B1} 5Ω $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.3A$ DUTY CYCLE≦1%	-	0.3	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.5	-	

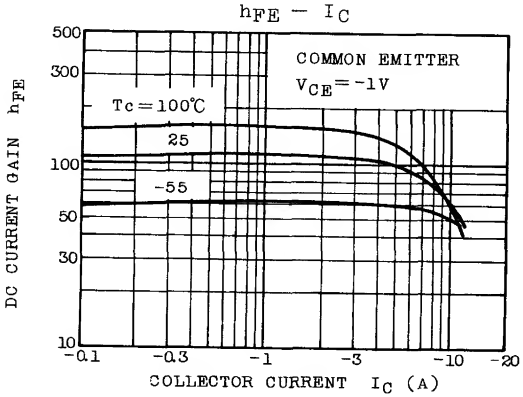
Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

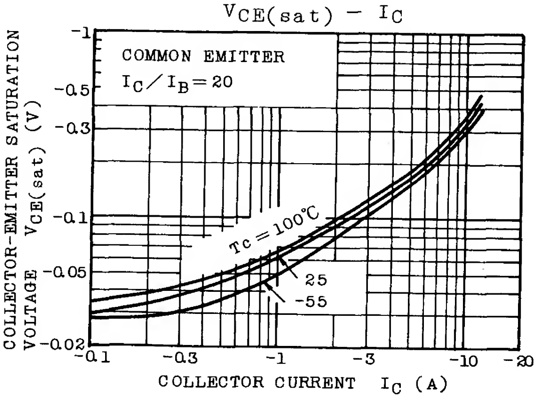

IC – VCE
COMMON EMITTER
Tc = 25°C
-100
-80
-70
-60
-50
-40
-30
-20
IB = -10mA
0
COLLECTOR CURRENT IC (A)
-10
-8
-6
-4
-2
0
0
-2
-4
-6
-8
-10
-12
-14
COLLECTOR-EMITTER VOLTAGE VCE (V)


VCE – IC
COMMON EMITTER
Tc = 25°C
IB = -30mA
-50
-70
-100
-150
-200
-300
-500
-700
-900
COLLECTOR-EMITTER VOLTAGE VCE (V)
-1.0
-0.8
-0.6
-0.4
-0.2
0
0
-2
-4
-6
-8
-10
-12
COLLECTOR CURRENT IC (A)

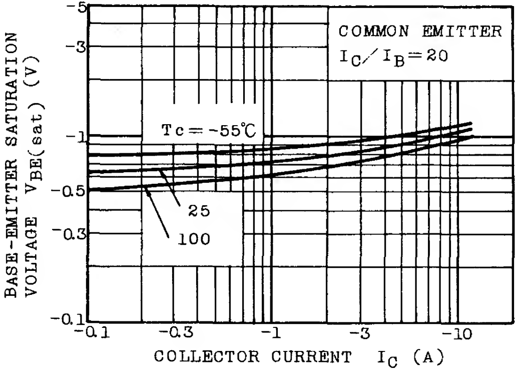

VCE – IC
COMMON EMITTER
Tc = 100°C
IB = 20mA
-40
-60
-80
-100
-150
-200
-300
-400
-600
-800
-1000
COLLECTOR-EMITTER VOLTAGE VCE (V)
-1.0
-0.8
-0.6
-0.4
-0.2
0
0
-2
-4
-6
-8
-10
-12
COLLECTOR CURRENT IC (A)


VCE – IC
COMMON EMITTER
Tc = -55°C
IB = -20mA
-40
-60
-80
-100
-150
-200
-300
-400
-500
-600
-800
-1000
COLLECTOR-EMITTER VOLTAGE VCE (V)
-1.0
-0.8
-0.6
-0.4
-0.2
0
0
-2
-4
-6
-8
-10
-12
COLLECTOR CURRENT IC (A)

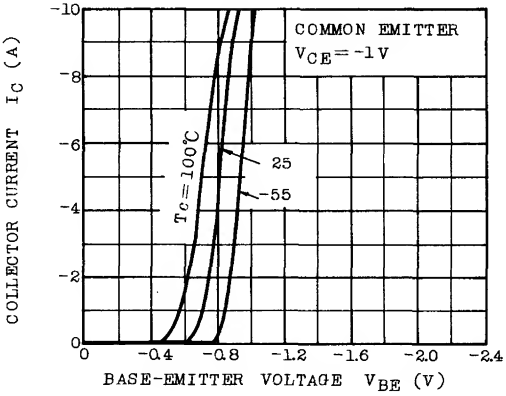

hFE – IC
COMMON EMITTER
VCE = -1V
Tc = 100°C
25
-55
DC CURRENT GAIN hFE
500
300
100
50
30
10
-0.1
-0.3
-1
-3
-10
-20
COLLECTOR CURRENT IC (A)


VCE(sat) – IC
COMMON EMITTER
IC/IB = 20
Tc = 100°C
25
-55
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
-1
-0.5
-0.3
-0.1
-0.05
-0.02
-0.1
-0.3
-1
-3
-10
-20
COLLECTOR CURRENT IC (A)

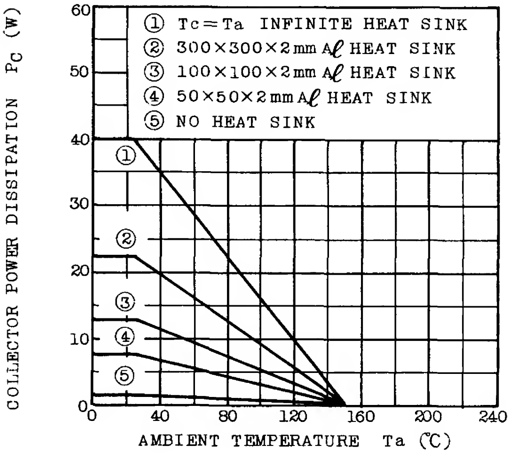
$V_{BE(sat)} - I_C$



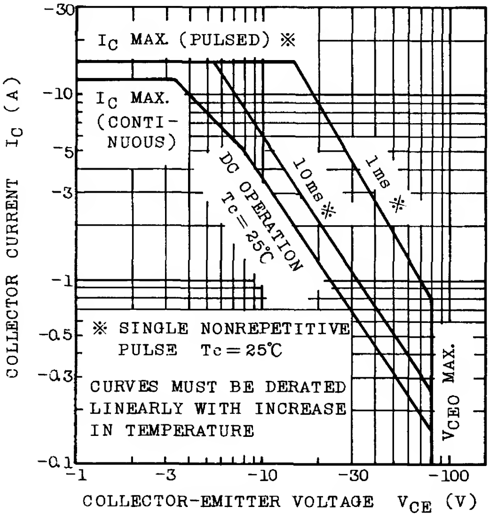
$I_C - V_{BE}$



$P_C - Ta$



SAFE OPERATING AREA



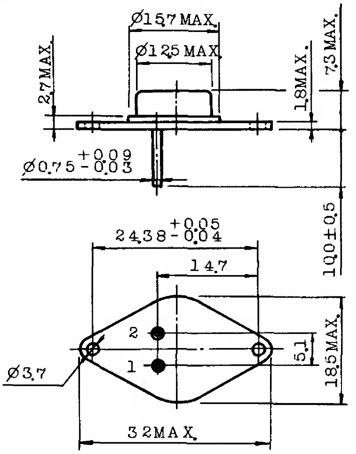
2SB
SERIES

SILICON PNP TRIPLE DIFFUSED MESA TYPE

2SB502A
2SB503A

AUDIO POWER AMPLIFIER APPLICATIONS.
REGULATOR APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO-66
EIAJ	TC-16A, TB-23
TOSHIBA	2-13A1A

Mounting kit No.AC74
Weight : 5.9g

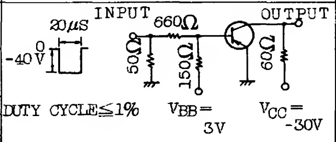
FEATURES :

- Low Saturation Voltage : $V_{CE(sat)}$=-1.5V(Max.)(I_C=-3A)
- Complementary to 2SD877.

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SB502A	V_{CBO}	-110	V
	2SB503A		-80	
Collector-Emitter Voltage	2SB502A	V_{CEO}	-80	V
	2SB503A		-50	
Emitter-Base Voltage		V_{EBO}	-10	V
Collector Current		I_C	-3	A
Emitter Current		I_E	3	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65 ∿ 150	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SB502A	I_{CBO}	V_{CB}=-110V, I_E=0	-	-	-100	μA
	2SB503A		V_{CB}=-80V, I_E=0	-	-	-100	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-10V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	2SB502A	$V_{(BR)CEO}$	I_C=-100mA, I_B=0	-80	-	-	V
	2SB503A			-50	-	-	
DC Current Gain		$h_{FE(1)}$ (Note 2)	V_{CE}=-5V, I_C=-0.5A(Note 1)	30	80	280	
		$h_{FE(2)}$	V_{CE}=-5V I_C=-2.5A(Note 1)	15	25	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A(Note 1)	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-3A, I_B=-0.3A(Note 1)	-	-	-1.8	
Transition Frequency		f_T	V_{CB}=-10V, I_C=-0.5A	-	5	-	MHz
Collector Output Capacitance		Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	200	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT 20μs 660Ω OUTPUT 0 -40V 50Ω 150Ω 60Ω DUTY CYCLE≦1% VBB=3V VCC=-30V	-	1.0	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	1.0	-	

Note 1 : Pulse Test : Pulse Width≦300μs, Duty Cycle≦2%
2 : $h_{FE(1)}$ classification R : 30∿70, O : 50∿140, Y : 100∿280

2SB552

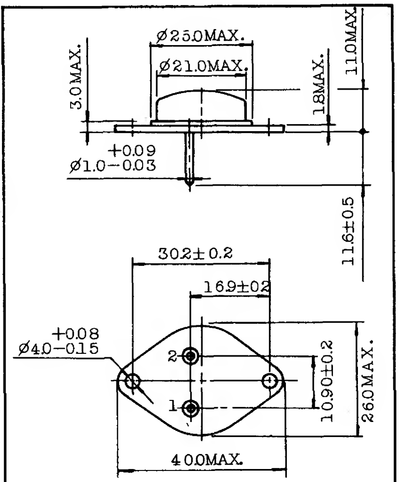
SILICON PNP TRIPLE DIFFUSED TYPE

HGIH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Collector Power Dissipation : P_C=150W (Tc=25°C)
- High Collector Current : I_C=-15A
- High Voltage : V_{CEO}=-180V
- Complementary to 2SD552.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

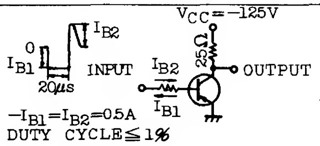
JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21A1A

Mounting Kit No. AC73
Weight : 12.9g

MAXIMUM RATINGS (Ta=25°C)

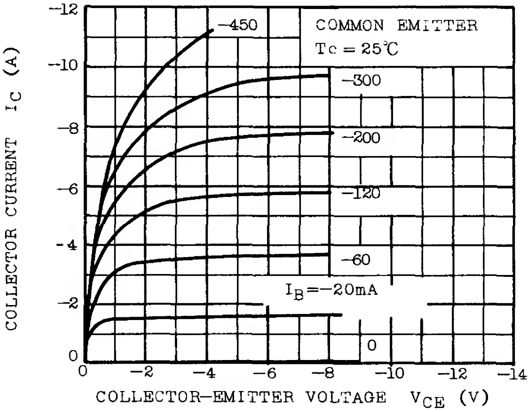
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-220	V
Collector-Emitter Voltage	V_{CEO}	-180	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-15	A
Base Current	I_B	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

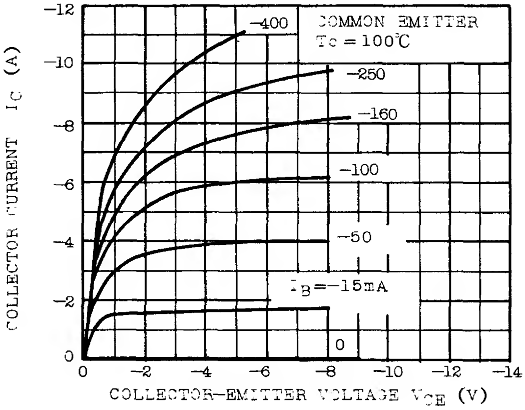
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-150V, I_E=0	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-180	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-5A	25	-	80	
		$h_{FE(2)}$	V_{CE}=-5V, I_C=-15A	10	15	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-10A, I_B=-1A	-	-	-2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-10A, I_B=-1A	-	-1.6	-2.5	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-1A	-	3.5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-50V, I_E=0, f=1MHz	-	300	-	pF
Switching Time	Turn-on Time	t_{on}	 V_{CC}=−125V 0 I_{B1} I_{B2} 20μs INPUT I_{B2} I_{B1} 25Ω OUTPUT $-I_{B1}=I_{B2}$=0.5A DUTY CYCLE≦1%	-	1	-	μs
	Storage Time	t_{stg}		-	4	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification BN : 25∿50, R : 40∿80

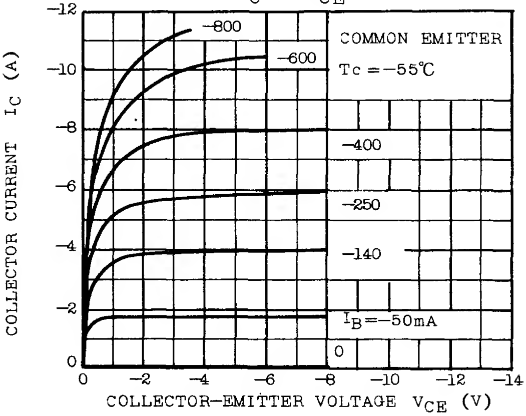
$I_C - V_{CE}$



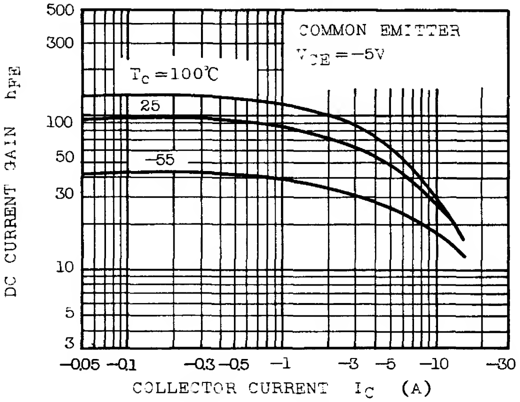
$I_C - V_{CE}$



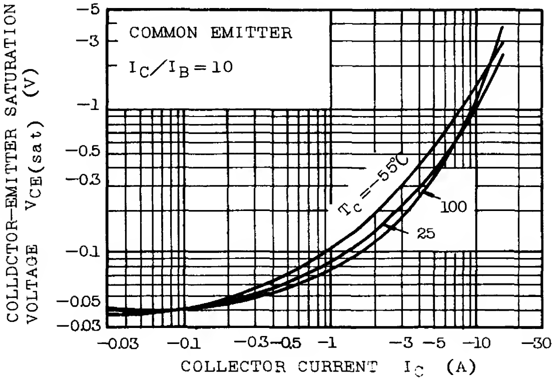
$I_C - V_{CE}$



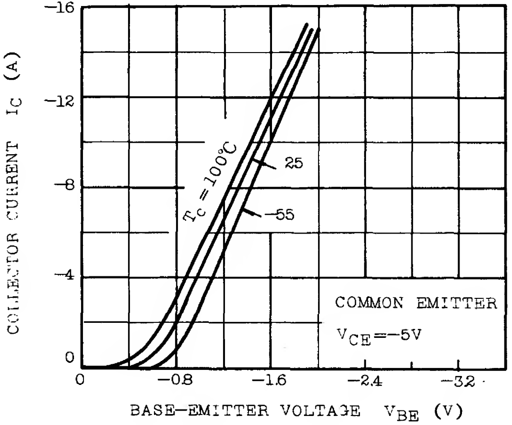
$h_{FE} - I_C$

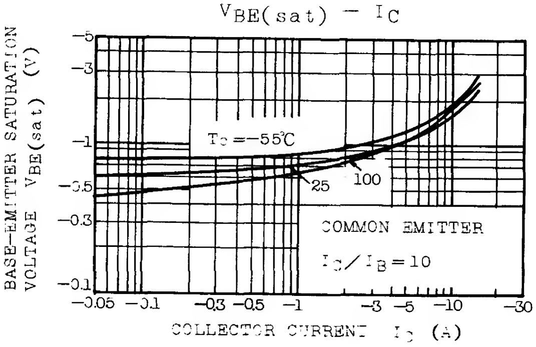


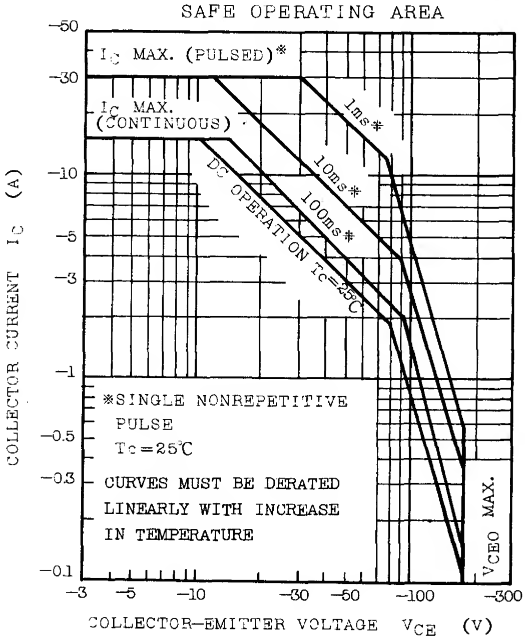
$V_{CE(sat)} - I_C$



$I_C - V_{BE}$




$V_{BE(sat)}$ — I_C
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
−5
−3
−1
−0.5
−0.3
−0.1
Tc = −55°C
25
100
COMMON EMITTER
$I_C/I_B=10$
−0.05
−0.1
−0.3
−0.5
−1
−3
−5
−10
−30
COLLECTOR CURRENT I_C (A)


SAFE OPERATING AREA
COLLECTOR CURRENT I_C (A)
−50
−30
−10
−5
−3
−1
−0.5
−0.3
−0.1
I_C MAX. (PULSED)*
I_C MAX. (CONTINUOUS)
1ms*
10ms*
100ms*
DC OPERATION Tc=25°C
*SINGLE NONREPETITIVE PULSE
Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX.
−3
−5
−10
−30
−50
−100
−300
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

2SB553

INDUSTRIAL APPLICATIONS

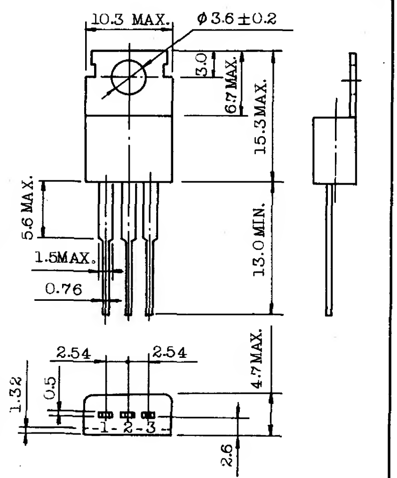
Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.4V (Max.) at I_C=-4A
- Complementray to 2SD553.



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

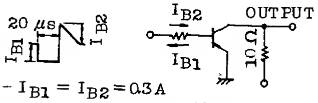
Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

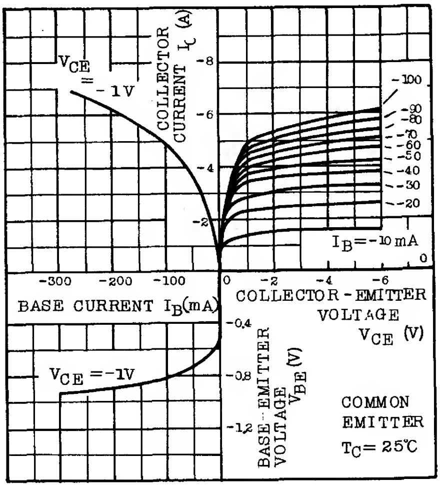
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-70	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-55∼150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

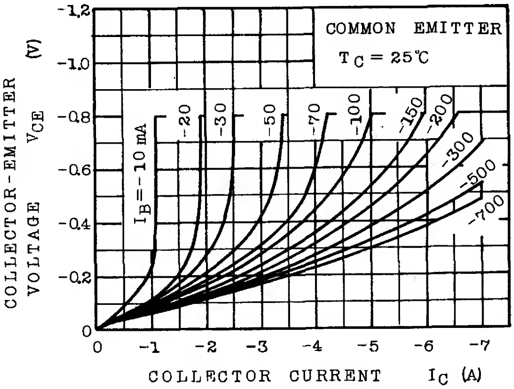
CHARACTERISITC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-70V, I_E=0	-	-	-30	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=-4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.9	-1.2	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1 MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 20 μs I_{B1} I_{B2} I_{B2} OUTPUT I_{B1} 10Ω $-I_{B1} = I_{B2}$ = 0.3A DUTY CYCLE ≦ 1% V_{CC} = -30V	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70∼140, Y : 120∼240

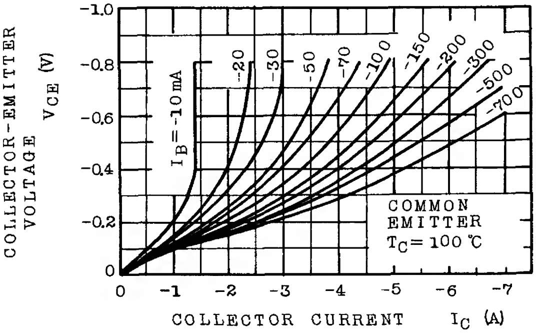
STATIC CHARACTERISTICS



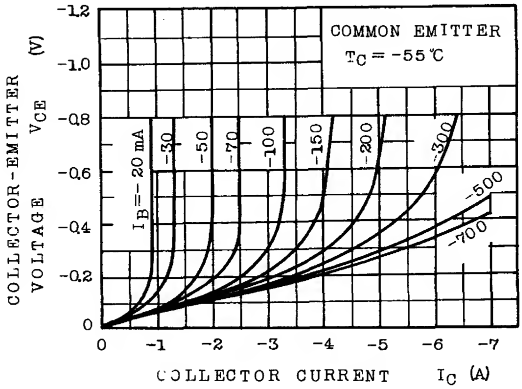
V_{CE} — I_C (LOW VOLTAGE REGION)



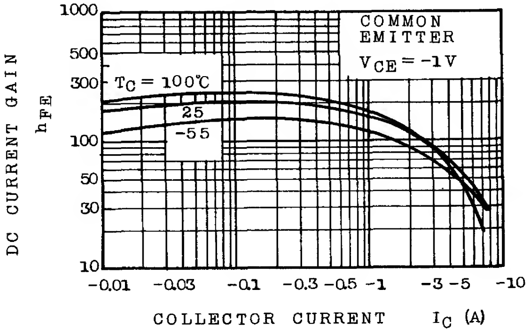
V_{CE} — I_C (LOW VOLTAGE REGION)



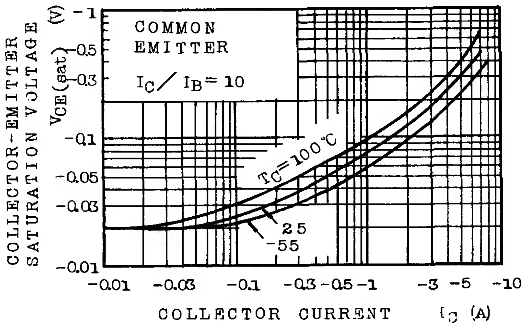
V_{CE} — I_C (LOW VOLTAGE REGION)



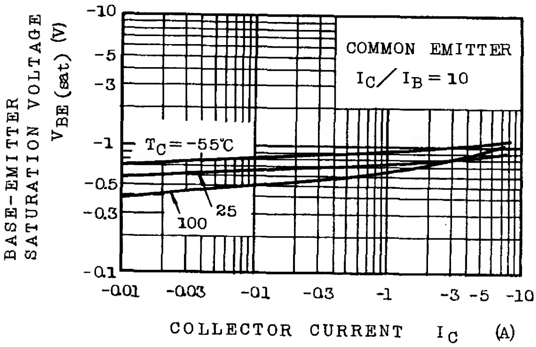
h_{FE} — I_C



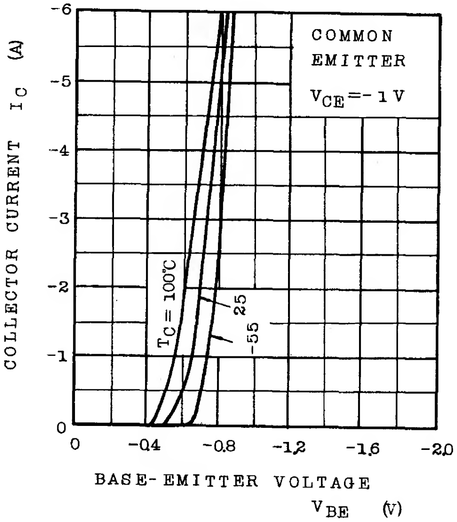
$V_{CE(sat)}$ — I_C



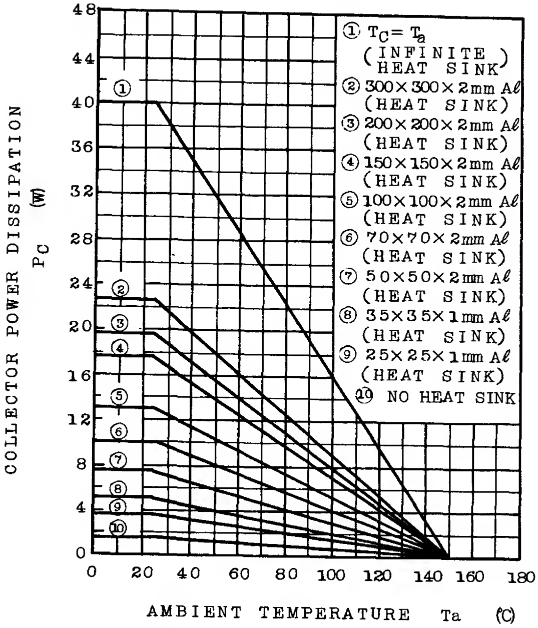
$V_{BE}(sat)$ – I_C



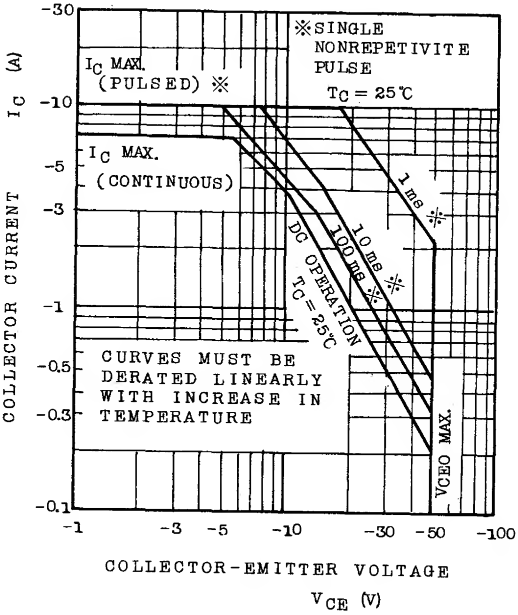
I_C – V_{BE}



P_C – T_a



SAFE OPERATING AREA



2SB554

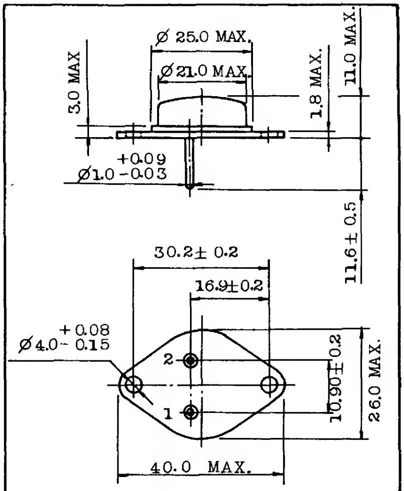
SILICON PNP TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C = 150W
- High Breakdown Voltage : V_{CEO} = -180V
- Complementary to 2SD424.
- Recommended for 100W High-Fiderity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21A1A

Mounting Kit No. AC73
Weight : 12.9g

MAXIMUM RATINGS (Ta=25°C)

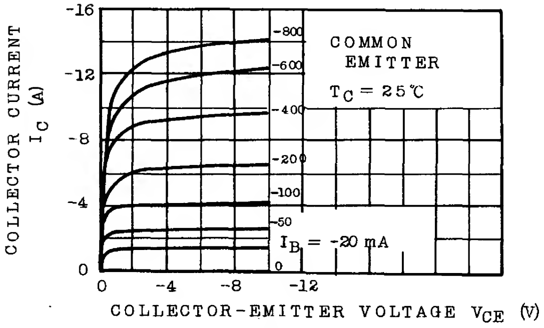
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-180	V
Collector-Emitter Voltage	V_{CEO}	-180	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-15	A
Emitter Current	I_E	15	A
Collector Power Dissipation (Tc = 25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ∿ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

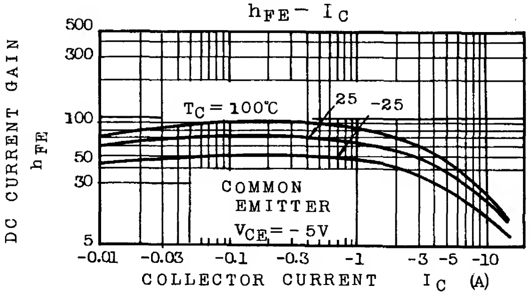
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-90V, I_E=0	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-0.1A, I_B=0	-180	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-2A	40	-	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-10A, I_B=-1A	-	-	-3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-10A	-	-	-2.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-2A	-	6	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	450	-	pF

Note: h_{FE} Classification R : 40 ∿ 80, O : 70 ∿ 140

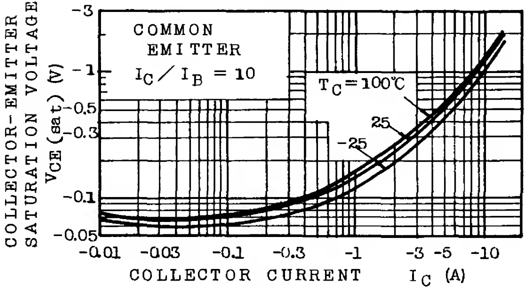
$I_C - V_{CE}$



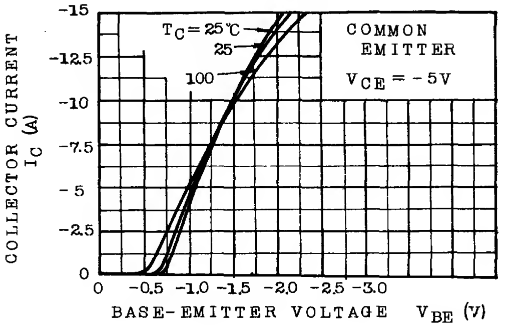
$h_{FE} - I_C$



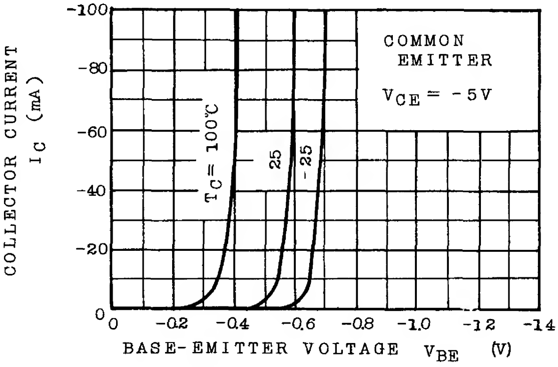
$V_{CE(sat)} - I_C$



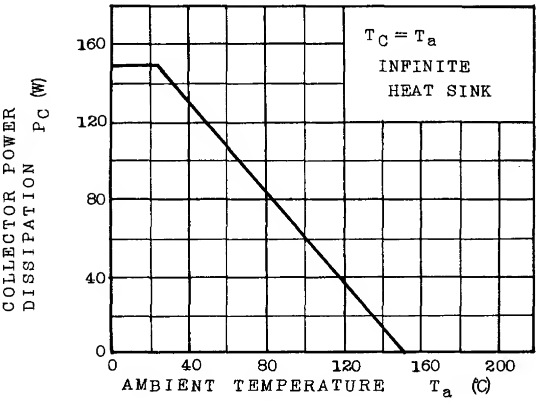
$I_C - V_{BE}$



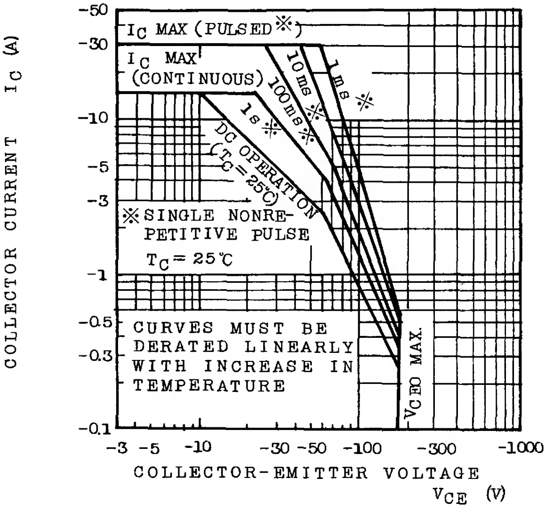
$I_C - V_{BE}$



$P_C - T_a$



SAFE OPERATING AREA



2SB595

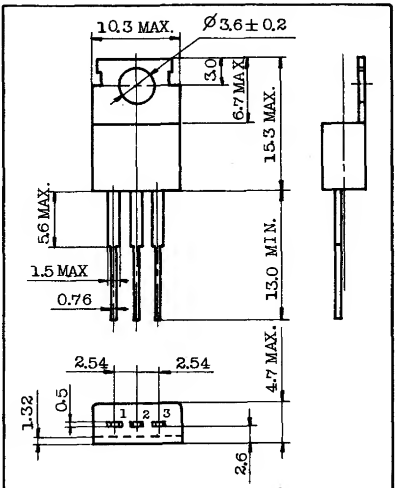
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=-100V
- Low Collector-Emitter Saturation Voltage
  : $V_{CE(sat)}$=-2.0V(Max.)
- Complementary to 2SD525.
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

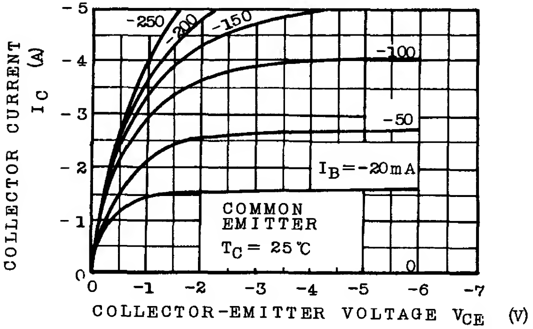
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Emitter Current	I_E	5	A
Base Current	I_B	-4	A
Collector Power Dissipation (T_C=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

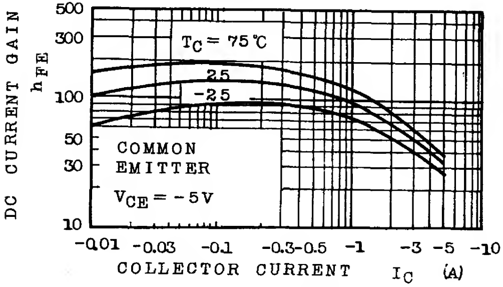
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	5	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ∿ 80, O : 70 ∿ 140, Y : 120 ∿ 240

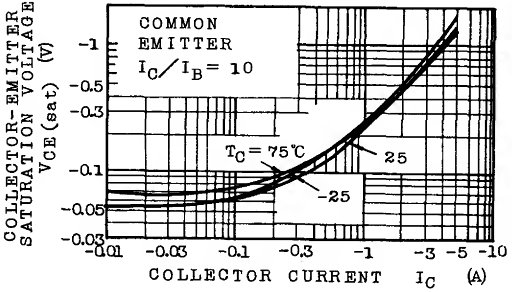
I_C — V_{CE}



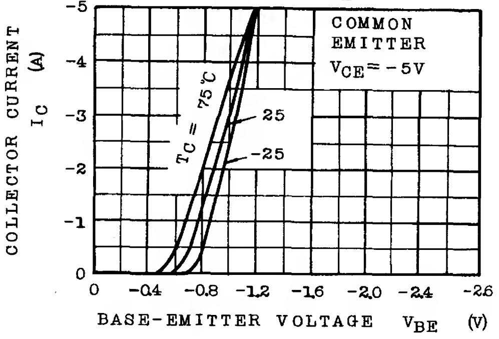
h_{FE} — I_C



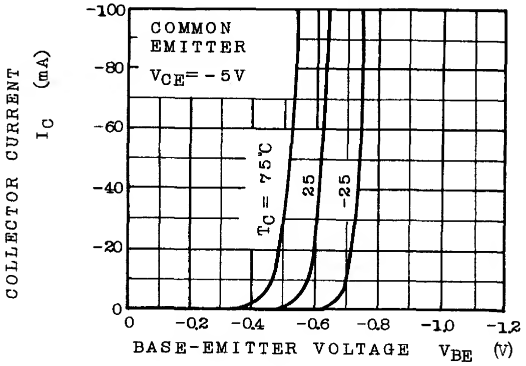
$V_{CE(sat)}$ — I_C



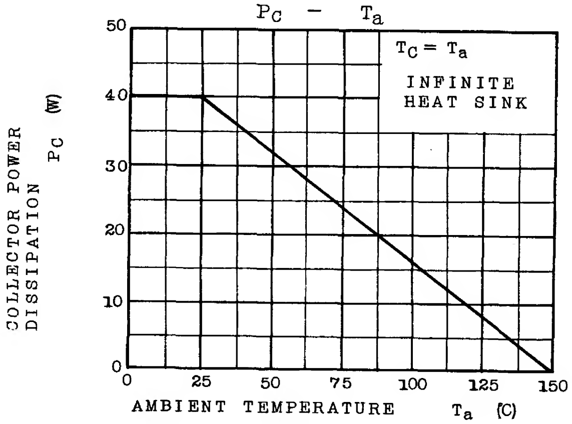
I_C — V_{BE}



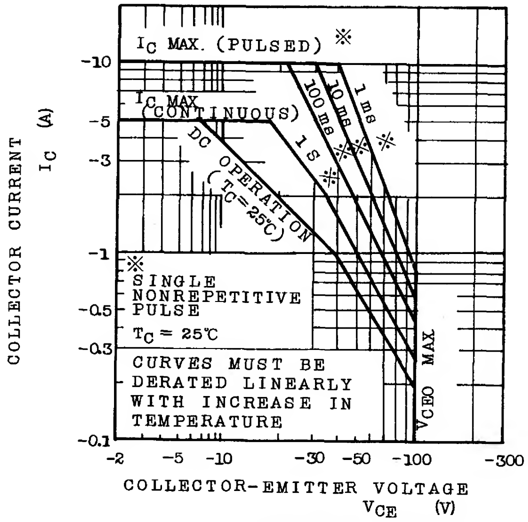
I_C — V_{BE}



P_C — T_a



SAFE OPERATING AREA



2SB596

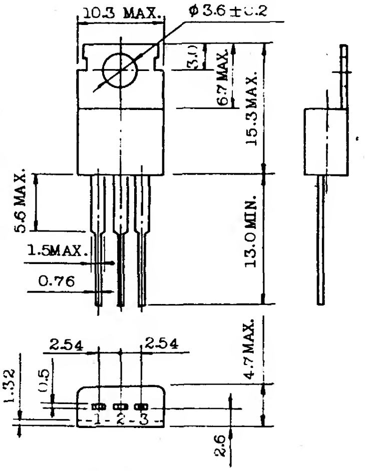
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}.
- Complementary to 2SD526.
- Recommended for 20∿25W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

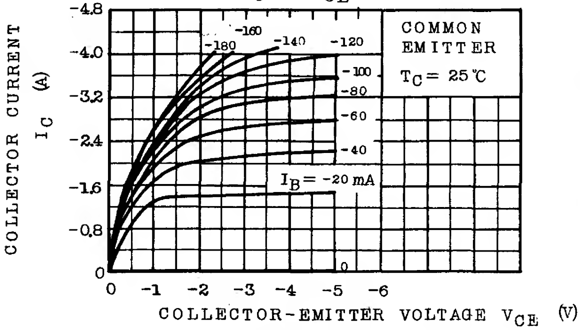
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-4	A
Emitter Current	I_E	4	A
Base Current	I_B	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

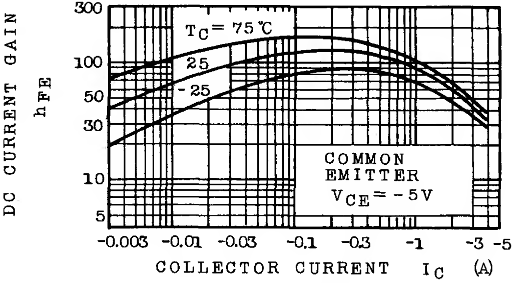
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-80V, I_E=0	-	-	-30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-3A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-0.5A	3	-	-	MHz
Collector Output Capacitance	Cob	VCB=-10V, IE=0, f=1 MHz	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ∿ 80, O : 70 ∿ 140, Y : 120 ∿ 240

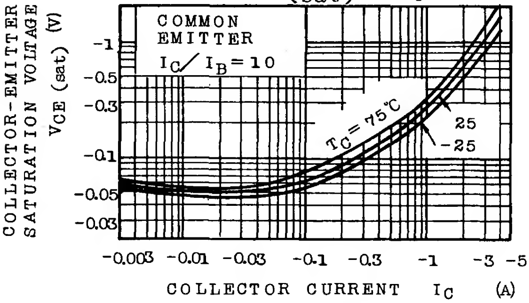
I_C – V_{CE}



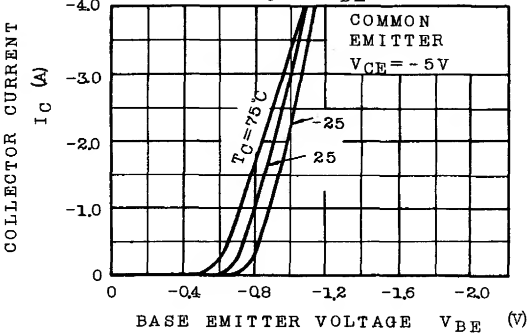
h_{FE} – I_C



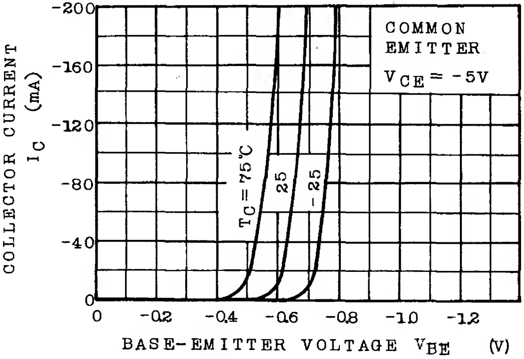
$V_{CE(sat)}$ – I_C



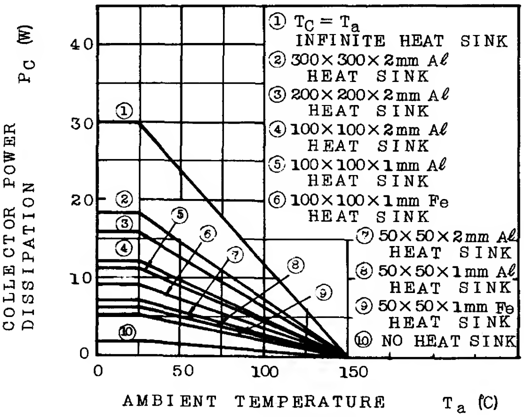
I_C – V_{BE}



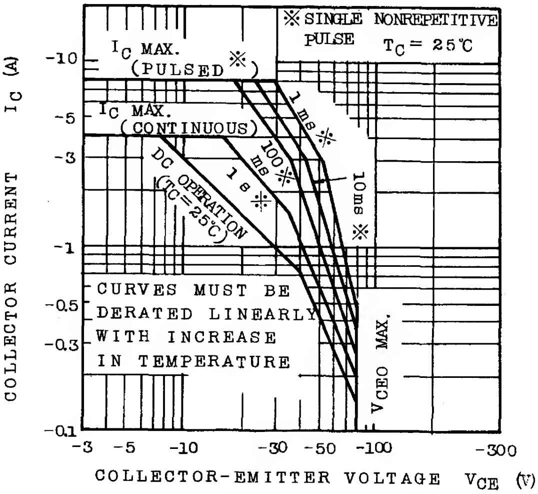
I_C – V_{BE}



P_C – T_a



SAFE OPERATING AREA



2SB673
2SB674
2SB675

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

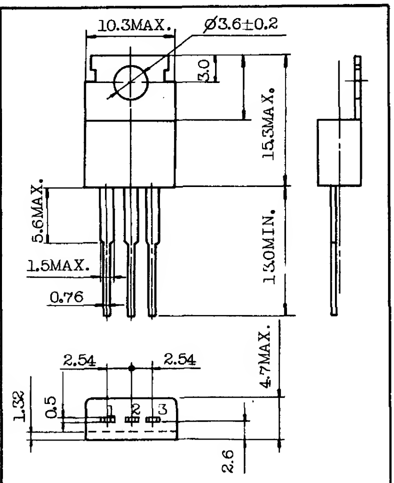
HIGH POWER SWITCHING APPLICATIONS.

HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain : h_{FE}=2000(Min.)(V_{CE}=-3V,I_C=-3A)
- Low Saturation Voltage : $V_{CE(sat)}$=-1.5V(Max.)(I_C=-3A)
- Complementary to 2SD633, 2SD634 and 2SD635.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

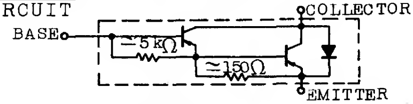
JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10 A 1 A

Mounting Kit No. AC75
Weight : 1.9g

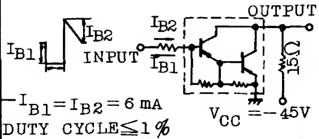
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SB673	V_{CBO}	-100	V
	2SB674		-80	
	2SB675		-60	
Collector-Emitter Voltage	2SB673	V_{CEO}	-100	V
	2SB674		-80	
	2SB675		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-0.2	A
Collector Power Dissipation (Tc=25°C)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-55∿150	°C

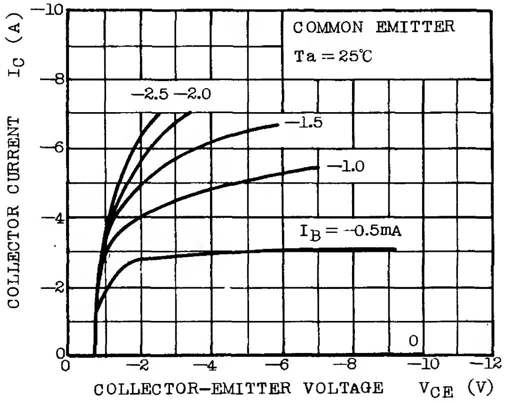
EQUIVALENT CIRCUIT



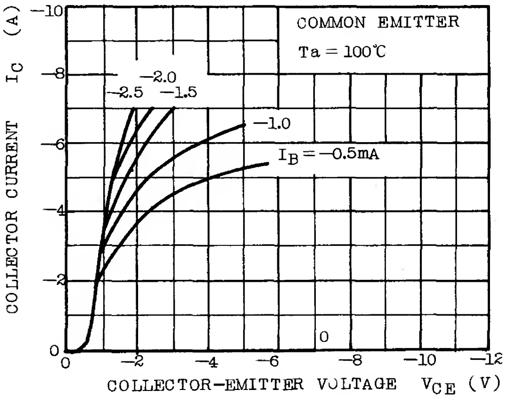
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SB673	I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-100	μA
	2SB674		V_{CB}=-80V, I_E=0	-	-	-100	
	2SB675		V_{CB}=-60V, I_E=0	-	-	-100	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-4.0	mA
Collector-Emitter Breakdown Voltage	2SB673	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-100	-	-	V
	2SB674			-80	-	-	
	2SB675			-60	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=-3V, I_C=-3A	2000	-	15000	
		$h_{FE(2)}$	V_{CE}=-3V, I_C=-7A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	I_C=-3A, I_B=-6mA	-	-0.95	-1.5	V
		$V_{CE(sat)(2)}$	I_C=-7A, I_B=-14mA	-	-1.3	-2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-3A, I_B=-6mA	-	-1.55	-2.5	V
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=I_{B2}$=6 mA DUTY CYCLE≦1% V_{CC} ≒ -45V	-	0.8	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	2.5	-	

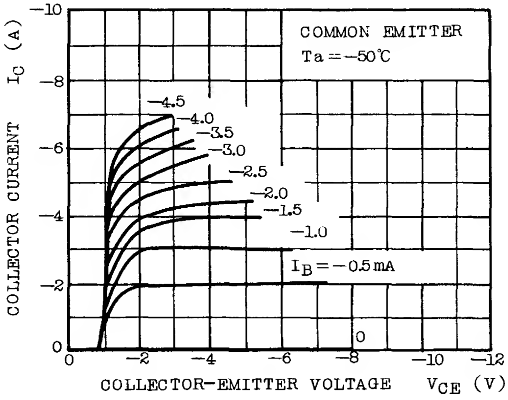
$I_C - V_{CE}$



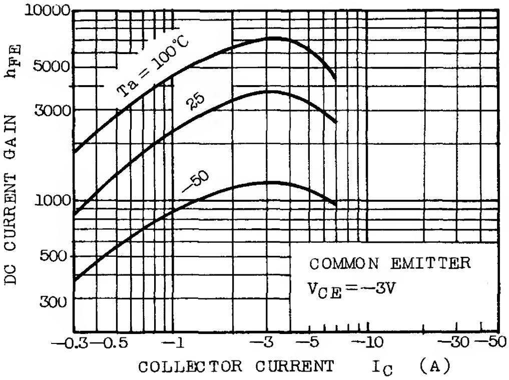
$I_C - V_{CE}$



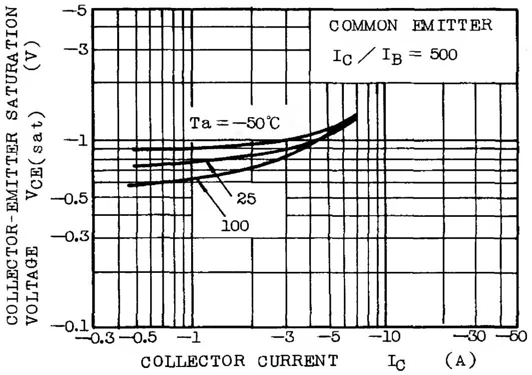
$I_C - V_{CE}$



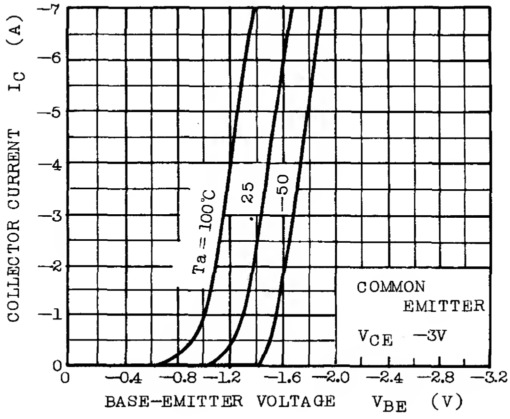
$h_{FE} - I_C$

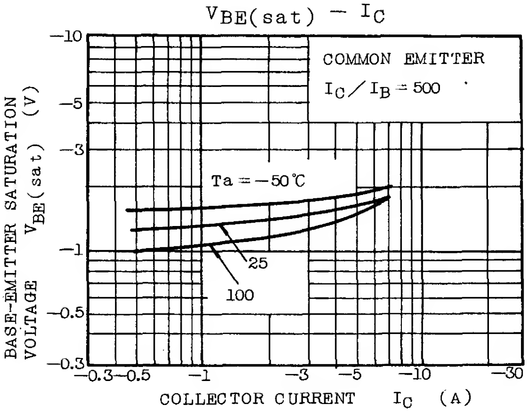


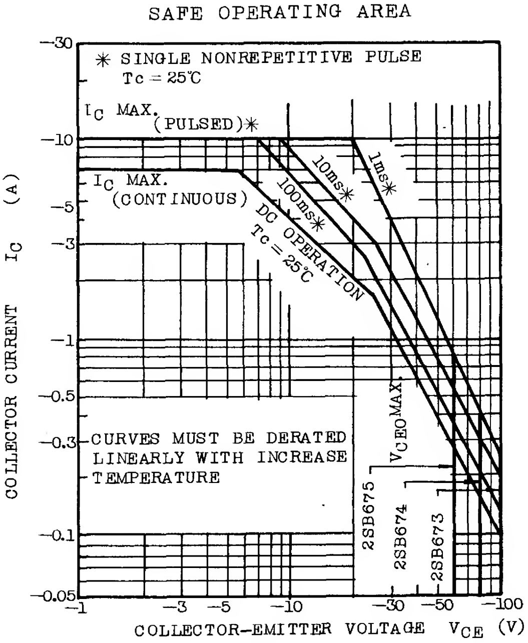
$V_{CE(sat)} - I_C$



$I_C - V_{BE}$




VBE(sat) – IC
COMMON EMITTER
IC/IB = 500
Ta = –50°C
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
–10
–5
–3
–1
–0.5
–0.3
–0.3
–0.5
–1
–3
–5
–10
–30
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
✳ SINGLE NONREPETITIVE PULSE
Tc = 25°C
IC MAX. (PULSED)✳
IC MAX. (CONTINUOUS)
10ms✳
1ms✳
100ms✳
DC OPERATION
Tc = 25°C
VCEO MAX.
CURVES MUST BE DERATED LINEARLY WITH INCREASE TEMPERATURE
2SB675
2SB674
2SB673
COLLECTOR CURRENT IC (A)
–30
–10
–5
–3
–1
–0.5
–0.3
–0.1
–0.05
–1
–3
–5
–10
–30
–50
–100
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

2SB676

SWITCHING APPLICATIONS.

HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

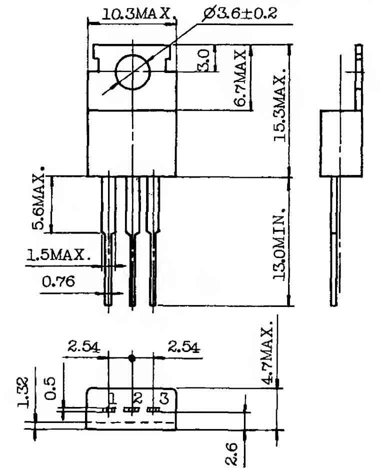
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000 (Min.) (V_{CE}=-2V, I_C=-1A)

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

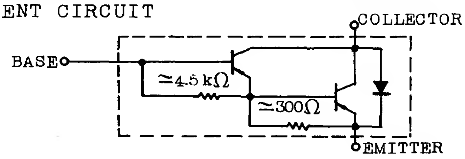
JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

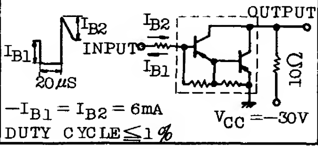
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-4	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

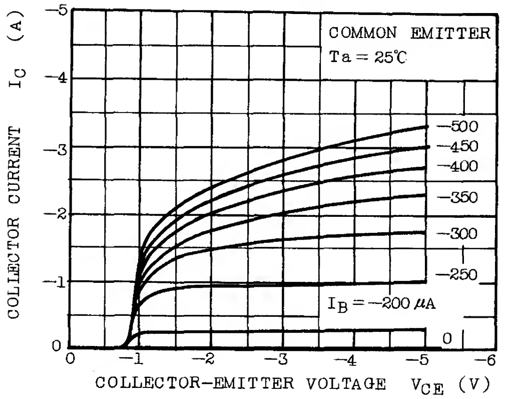
EQUIVALENT CIRCUIT



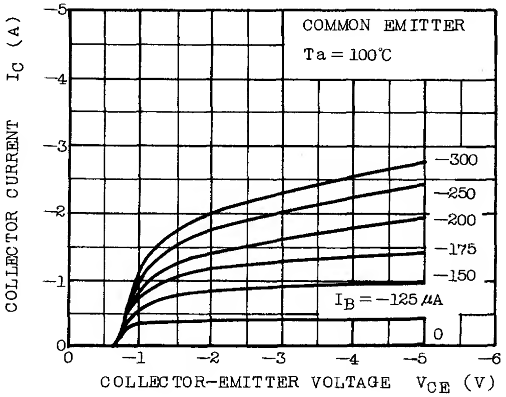
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-20	µA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-3A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-3A, I_B=-6mA	-	-	-1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-3A, I_B=-6mA	-	-	-2.0	V
Switching Time	Turn-on Time	t_{on}	 $-I_{B1} = I_{B2}$ = 6mA DUTY CYCLE≦1%	-	0.15	-	µs
	Storage Time	t_{stg}		-	0.80	-	
	Fall Time	t_f		-	0.40	-	

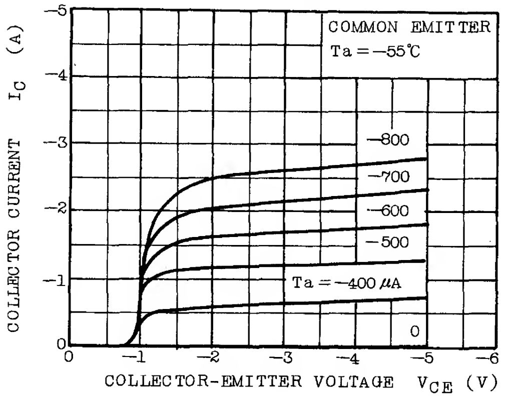
I_C – V_{CE}



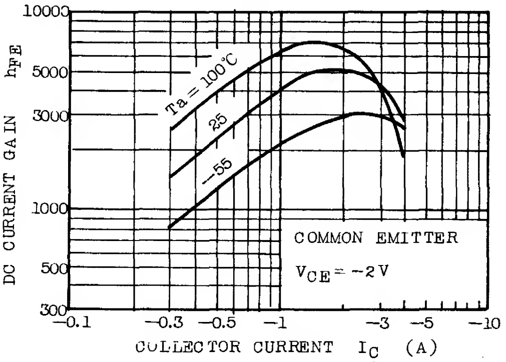
I_C – V_{CE}



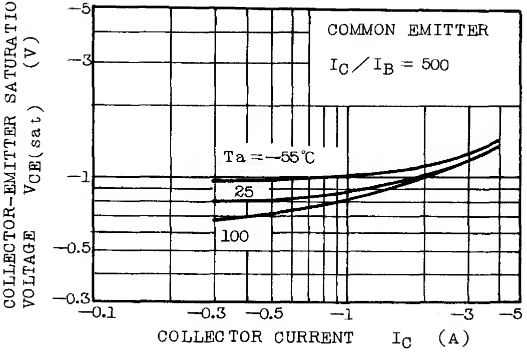
I_C – V_{CE}



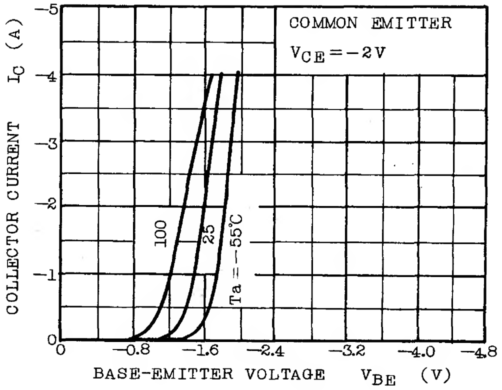
h_{FE} – I_C

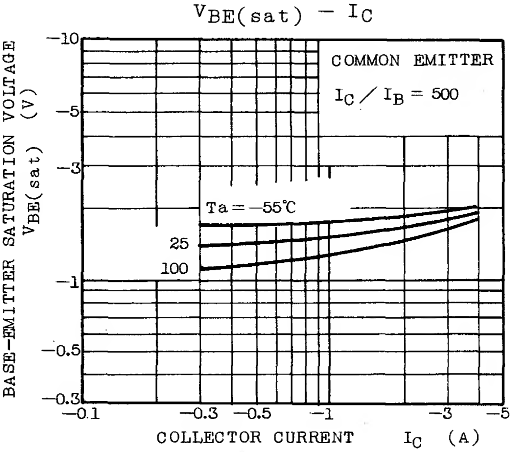


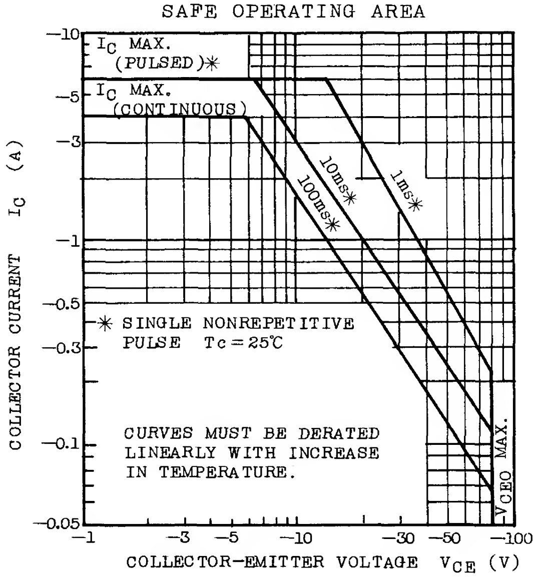
$V_{CE(sat)}$ – I_C

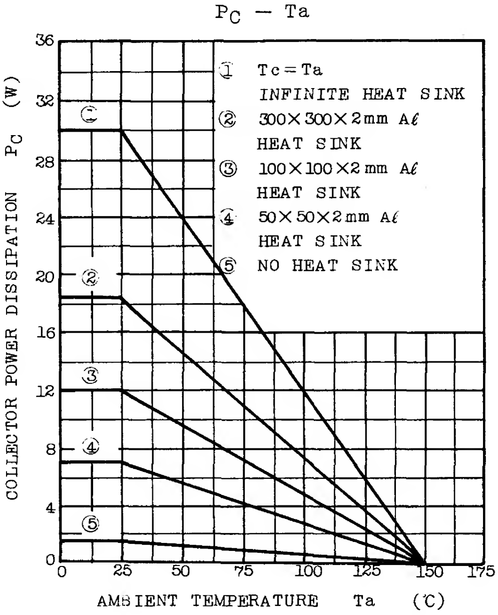


I_C – V_{BE}




VBE(sat) − IC
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
COMMON EMITTER
IC / IB = 500
Ta = −55℃
25
100
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.3
−0.5
−1
−3
−5
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
IC MAX. (PULSED)✳
IC MAX. (CONTINUOUS)
10ms✳
100ms✳
1ms✳
✳ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.
COLLECTOR CURRENT IC (A)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−1
−3
−5
−10
−30
−50
−100
COLLECTOR-EMITTER VOLTAGE VCE (V)


PC − Ta
COLLECTOR POWER DISSIPATION PC (W)
① Tc = Ta INFINITE HEAT SINK
② 300×300×2mm Aℓ HEAT SINK
③ 100×100×2mm Aℓ HEAT SINK
④ 50×50×2mm Aℓ HEAT SINK
⑤ NO HEAT SINK
①
②
③
④
⑤
36
32
28
24
20
16
12
8
4
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)

2SB677

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

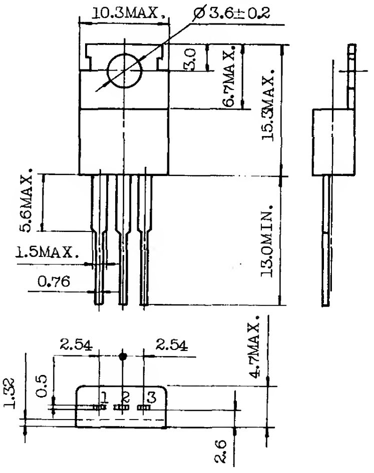
SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000 (Min.) (V_{CE}=-2V, I_C=-1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=-1.5V (Max.) (I_C=-2A)

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

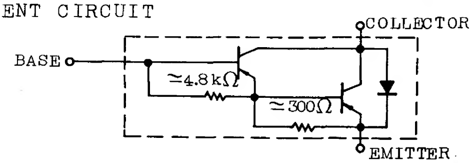
JEDEC	TO − 220AB
EIAJ	SC − 46
TOSHIBA	2 − 10A1A

Mounting Kit No. AC75
Weight : 1.9g

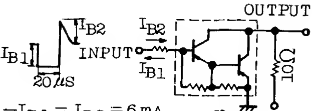
MAXIMUM RATINGS (Ta=25°C)

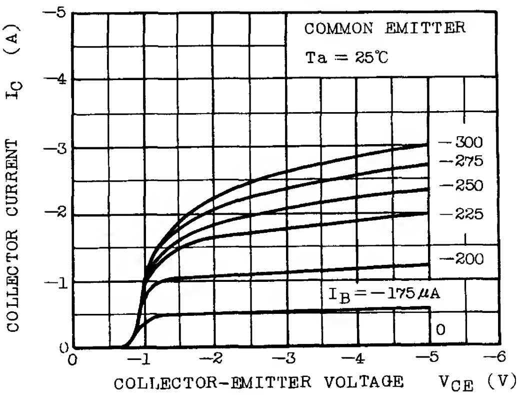
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-40	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

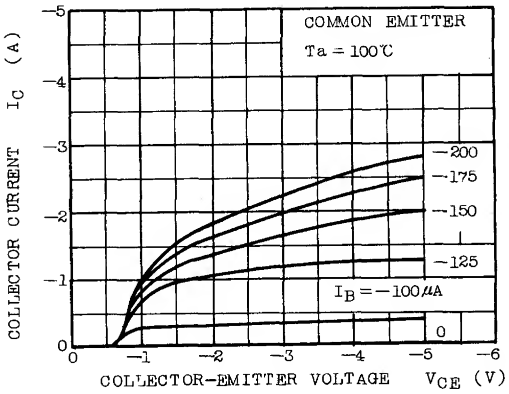
EQUIVALENT CIRCUIT

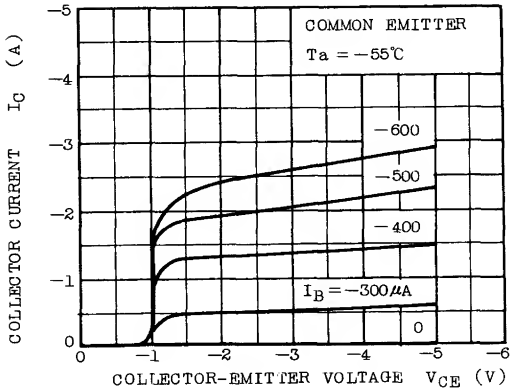


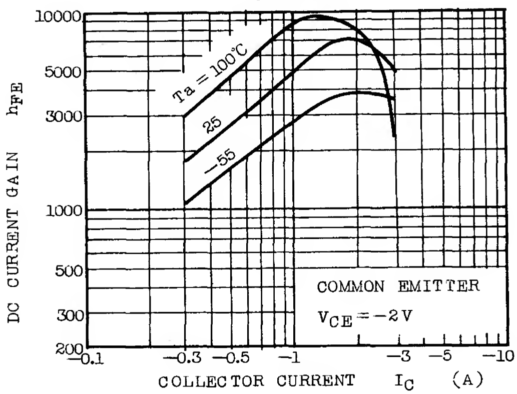
ELECTRICAL CHARACTERISTICS (Ta=25°C)

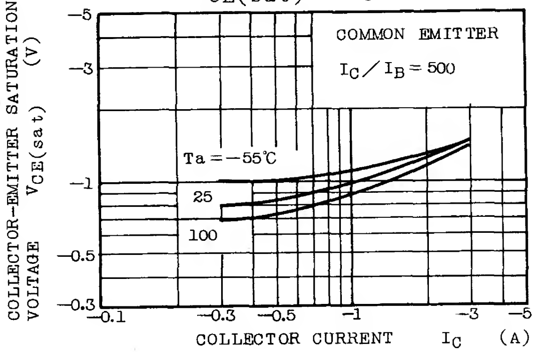
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-60V, I_E=0	-	-	-20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-25mA, I_B=0	-40	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-3A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-2A, I_B=-4mA	-	-	-1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-2A, I_B=-4mA	-	-	-2.0	V
Switching Time	Turn-on Time	t_{on}	 OUTPUT I_{B2} I_{B2} I_{B1} INPUT I_{B1} 20μs 10Ω V_{CC}=−30V	-	0.30	-	μs
	Storage Time	t_{stg}		-	0.60	-	
	Fall Time	t_f	$-I_{B1}=I_{B2}$=6mA DUTY CYCLE≦1%	-	0.25	-	

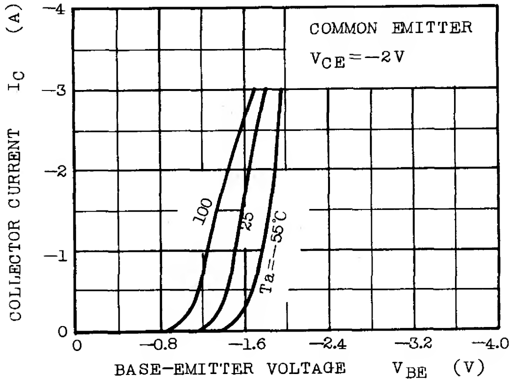

$I_C - V_{CE}$


$I_C - V_{CE}$

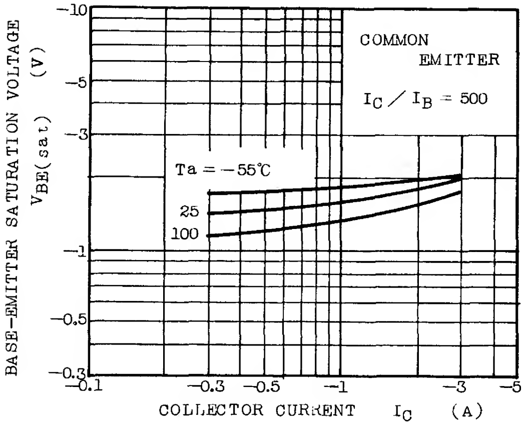

$I_C - V_{CE}$


$h_{FE} - I_C$

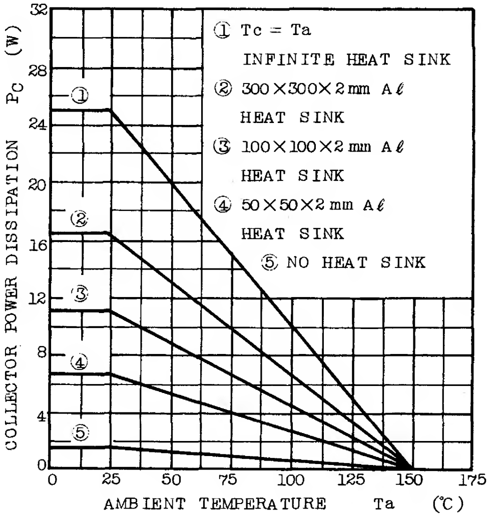

$V_{CE(sat)} - I_C$


$I_C - V_{BE}$

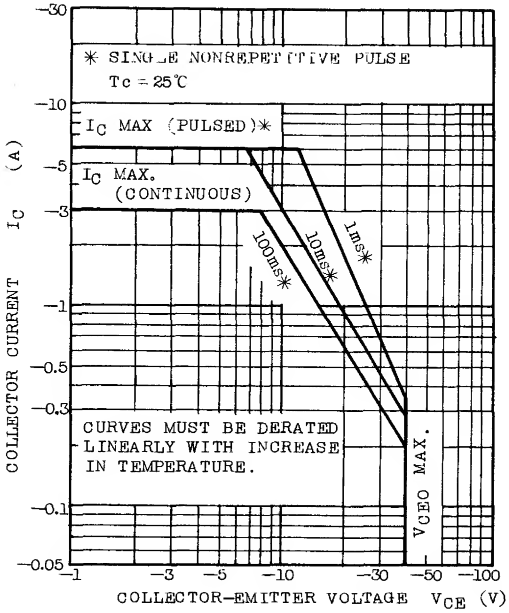
$V_{BE(sat)}$ − I_C



P_C − Ta



SAFE OPERATING AREA



SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

2SB678

INDUSTRIAL APPLICATIONS

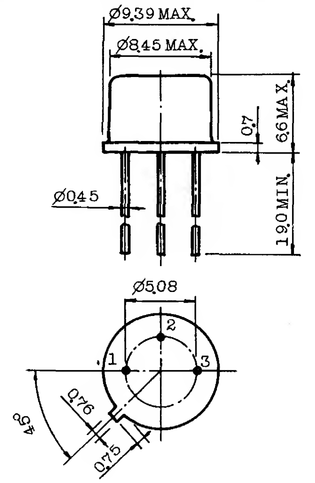
LOW FREQUENCY MEDIUM POWER AMPLIFIER AND MEDIUM SPEED SWITCHING APPLICATIONS.

PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER DRIVE APPLICATIONS.

FEATURES :

- High DC Current Gain : $h_{FE(2)}$=1000(Min.) (V_{CE}=-2V, I_C=-1A)
- Low Saturation Voltage : V_{CE}(sat)=-1.5V(Max.)(I_C=-1A)
- Complementary to 2SD688.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

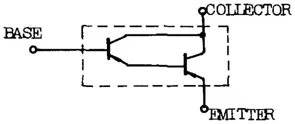
JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1A

Weight : 1.13g

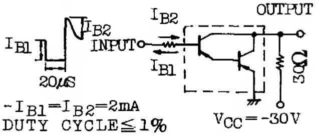
MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-100	V
Emitter-Base Voltage		V_{EBO}	-10	V
Collector Current		I_C	-1.5	A
Emitter Current		I_E	1.5	A
Collector Power Dissipation	(Ta = 25°C)	P_C	0.8	W
	(Tc = 25°C)		8	
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-10V, I_C=0	-	-	-10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-100	-	-	V
	Base-Emitter	$V_{(BR)EBO}$	I_E=-5mA, I_C=0	-10	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-0.1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-1A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-1A, I_B=-2mA	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-1A, I_B=-2mA	-	-	-2.5	
Switching Time	Turn-on Time	t_{on}	 $-I_{B1}=I_{B2}$=2mA DUTY CYCLE≦1%	-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.7	-	

2SB679

SILICON PNP TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

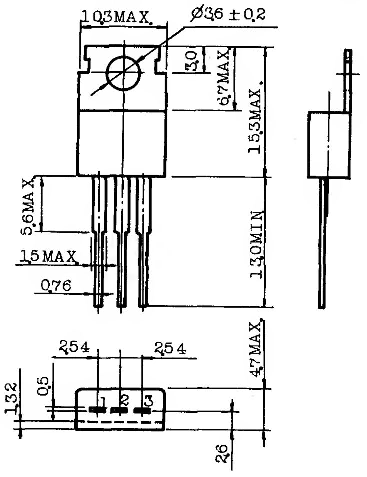
LOW FREQUENCY MEDIUM POWER AMPLIFIER AND MEDIUM SPEED SWITCHING APPLICATIONS.

PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER DRIVE APPLICATIONS.

FEATURES :

- High DC Current Gain : $h_{FE(2)}$=1000(Min.)
  (V_{CE}=-2V, I_C=-1A)
- Low Saturation Voltage : $V_{CE(sat)}$=-1.5V(Max.)(I_C=-1A)
- Complementary to 2SD689.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

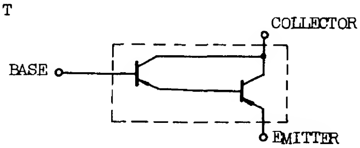
Mounting kit No.AC75

Weight : 1.9g

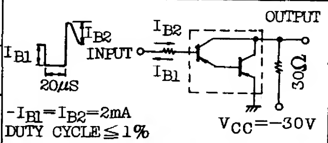
MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-10	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation (Tc = 25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-10V, I_C=0	-	-	-10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-100	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	I_E=-5mA, I_C=0	-10	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-0.1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-1A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-1A, I_B=-2mA	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-1A, I_B=-2mA	-	-	-2.5	
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.7	-	

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

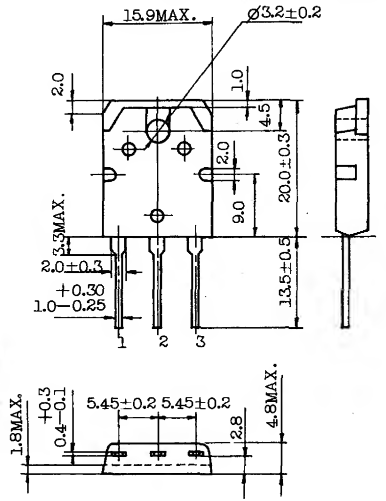
2SB686

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SD716.
- Recommended for 30 ∿ 35W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

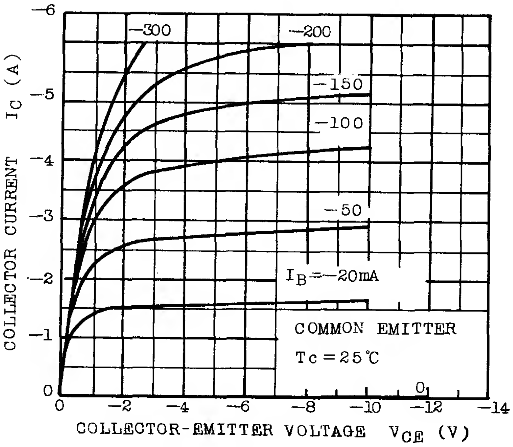
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-6	A
Emitter Current	I_E	6	A
Collector Power Dissipation (Tc=25°C)	P_C	60	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

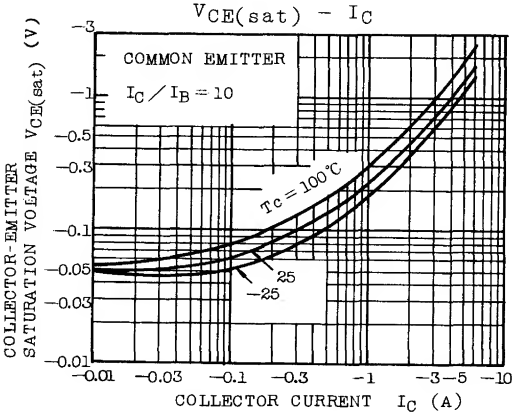
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	270	-	pF

Note : h_{FE} Classification R : 55∿110, O : 80∿160

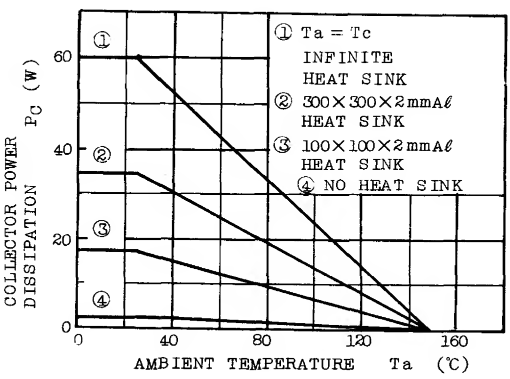
I_C – V_{CE}



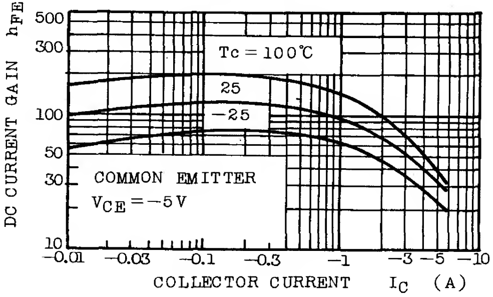
$V_{CE(sat)}$ – I_C



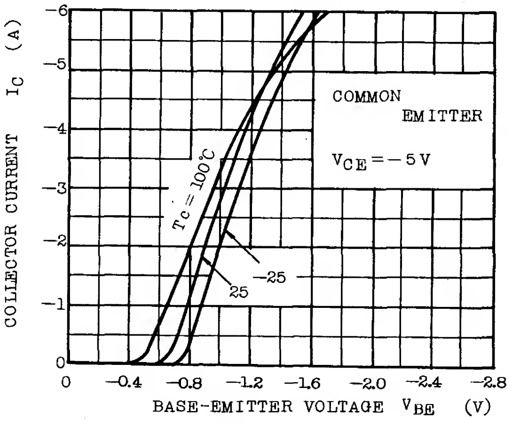
P_C – Ta



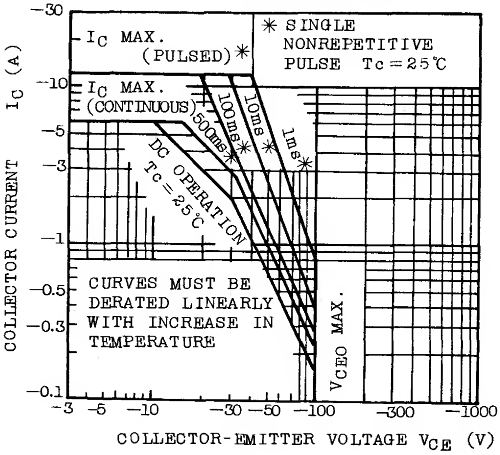
h_{FE} – I_C



I_C – V_{BE}



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

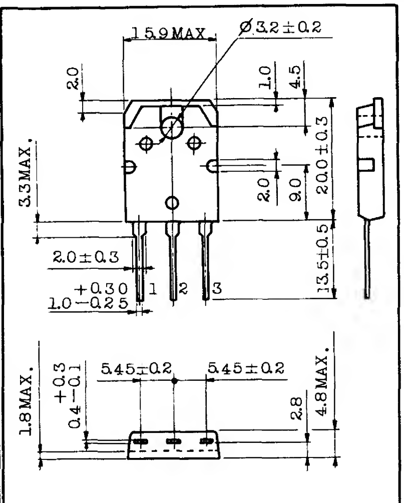
2SB688

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SD718.
- Recommended for 45～50W audio frequency amplifier output stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

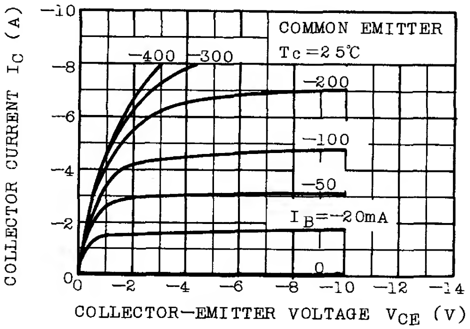
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-120	V
Collector-Emitter Voltage	V_{CEO}	-120	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-8	A
Base Current	I_B	-0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

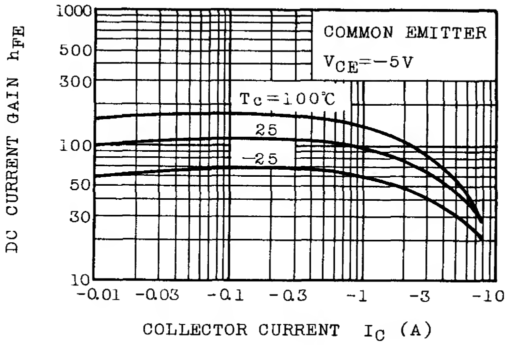
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-120V, I_E=0	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-120	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-2.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance	Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	280	-	pF

Note: h_{FE} Classification R:55～110, O:80～160

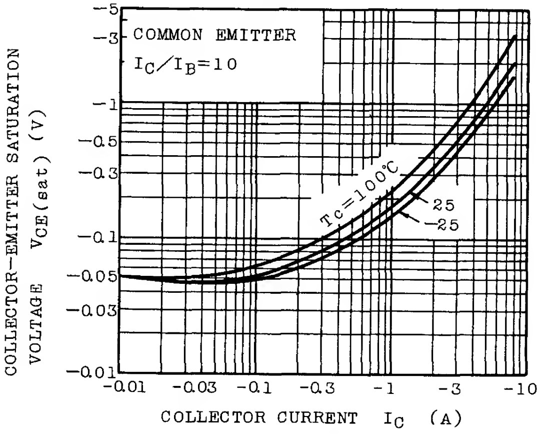
$I_C - V_{CE}$



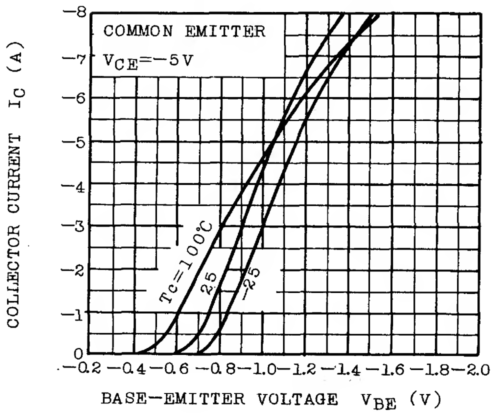
$h_{FE} - I_C$



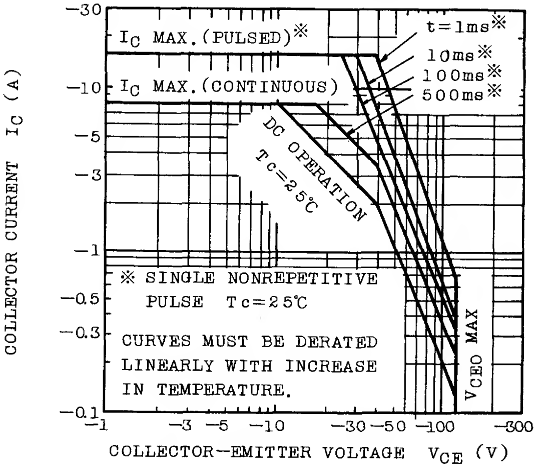
$V_{CE(sat)} - I_C$



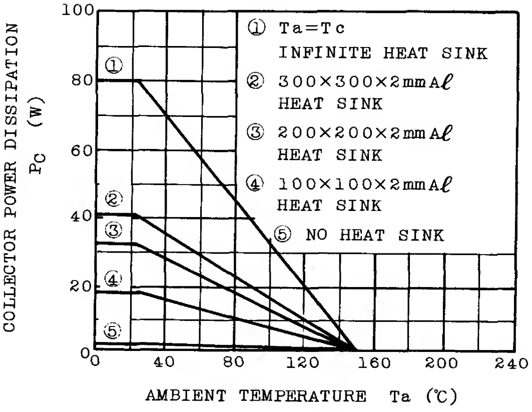
$I_C - V_{BE}$



SAFE OPERATING AREA



$P_C - Ta$



SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

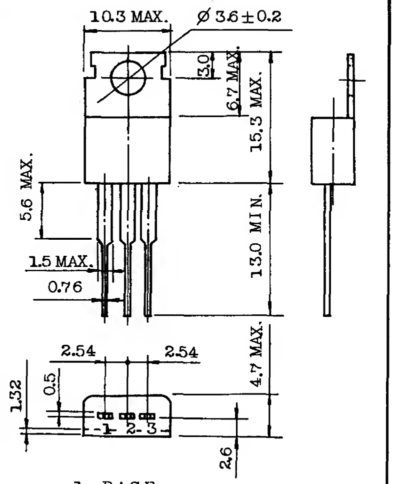
2SB753

INDUSTRIAL APPLICATIONS
Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : I_C=-7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.5V(Max.) at I_C=-4A
- High Collector Power Dissipation.
- Complementary to 2SD843.



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

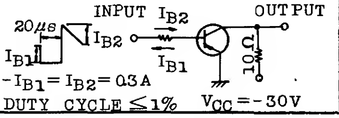
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

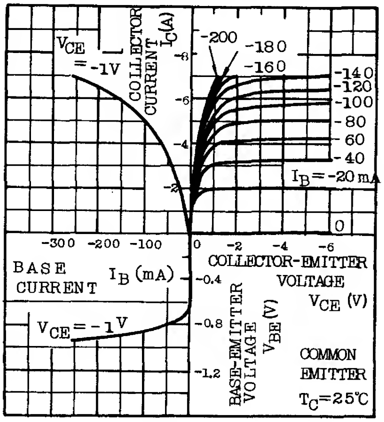
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C	P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

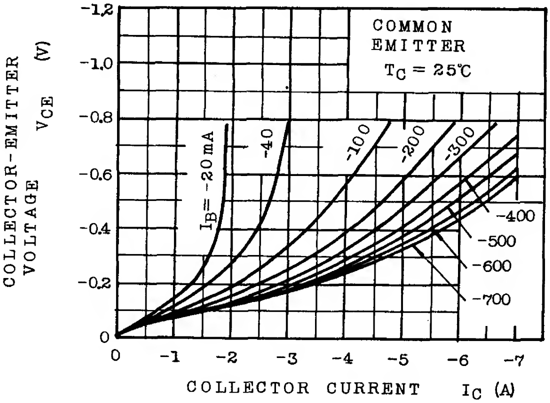
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=-4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.9	-1.4	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1 MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B2} OUTPUT 20μs I_{B2} I_{B1} I_{B1} 10Ω $-I_{B1}=I_{B2}$=0.3A DUTY CYCLE ≤1% V_{CC}=-30V	-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70 ∿ 140, Y : 120 ∿ 240

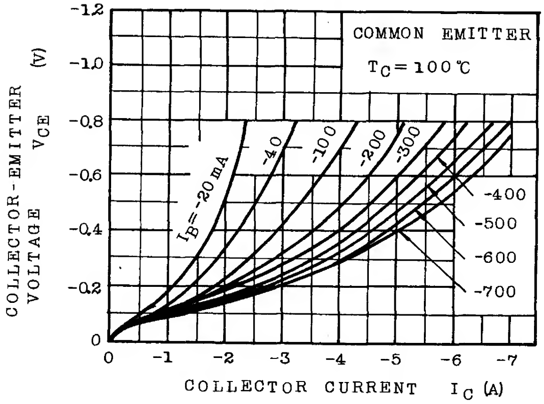
STATIC CHARACTERISTICS



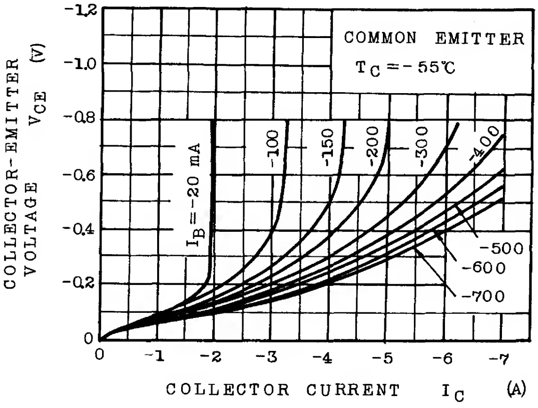
V_{CE} − I_C



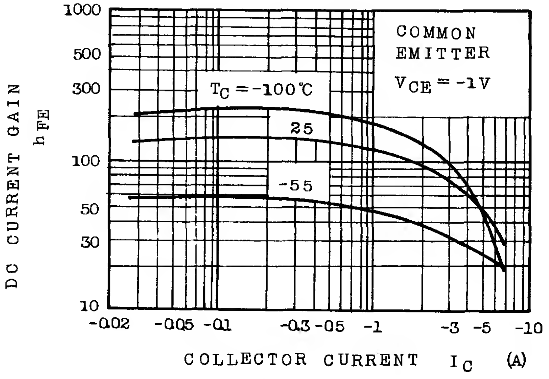
V_{CE} − I_C



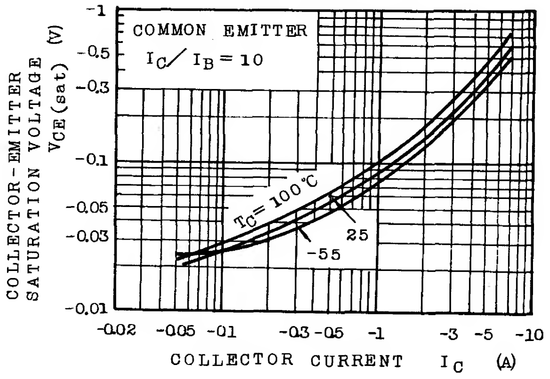
V_{CE} − I_C

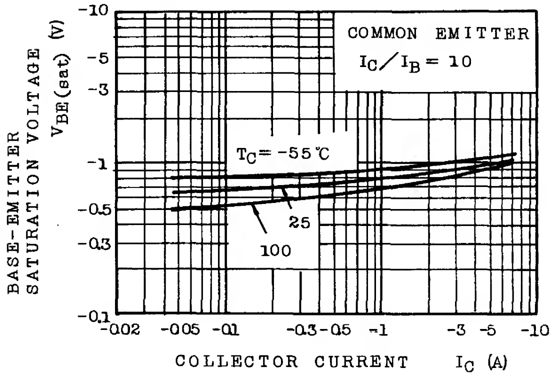


h_{FE} − I_C

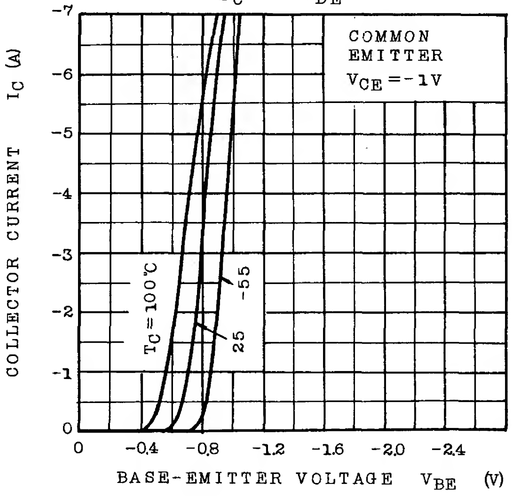


$V_{CE(sat)}$ − I_C

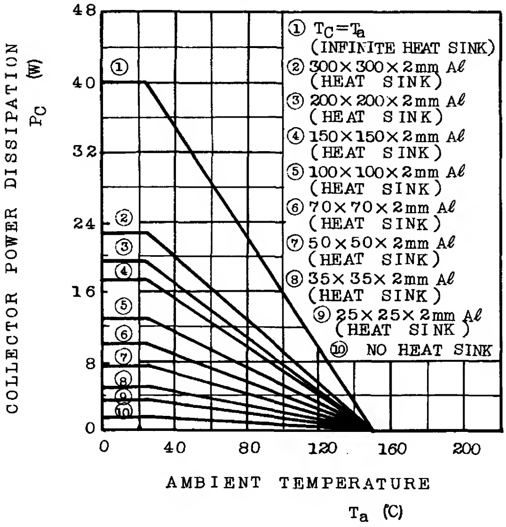




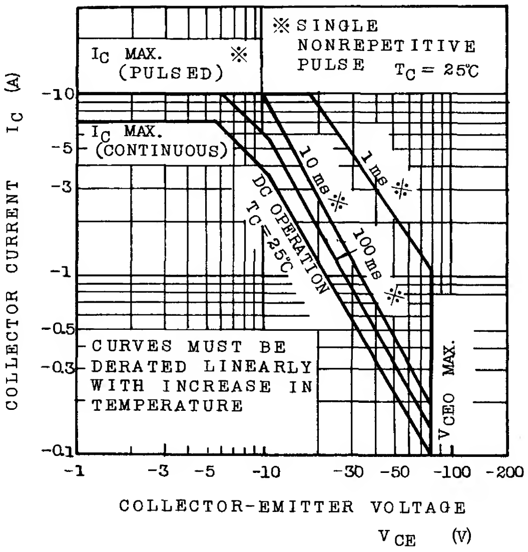
VBE(sat) – IC



IC – VBE



PC – Ta



SAFE OPERATING AREA

2SB754

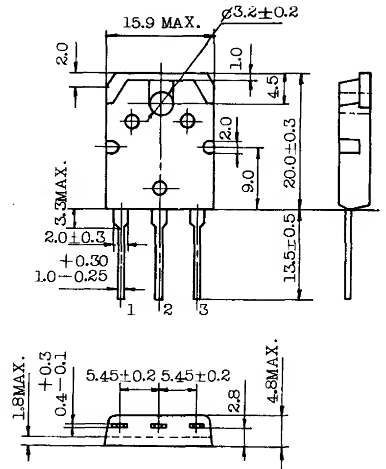
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : I_C=-7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.4V (Max.) at I_C=-4A
- High Power Dissipation : P_C=60W at Tc=25°C
- Complementary to 2SD844.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

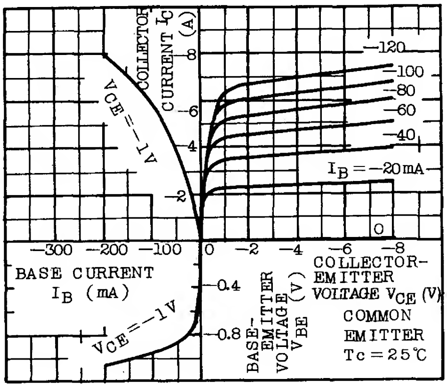
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-50	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Emitter Current		I_E	7	A
Collector Power Dissipation	Ta=25°C	P_C	2.5	W
	Tc=25°C		60	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

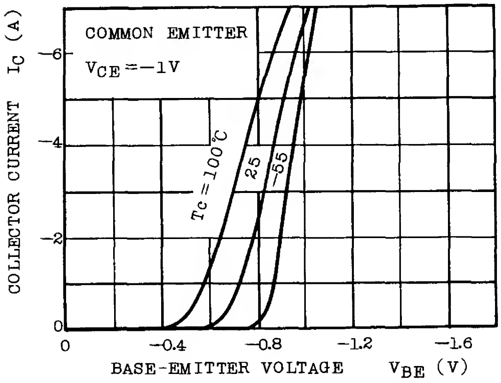
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-50V, I_E=0	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-50	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
	$h_{FE(2)}$	V_{CE}=-1V, I_C=-4A	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.2	-0.4	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-1V, I_C=-4A	-	-0.9	-1.2	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	300	-	pF

Note : $h_{FE(1)}$ Classification O : 70∿140 Y : 120∿240

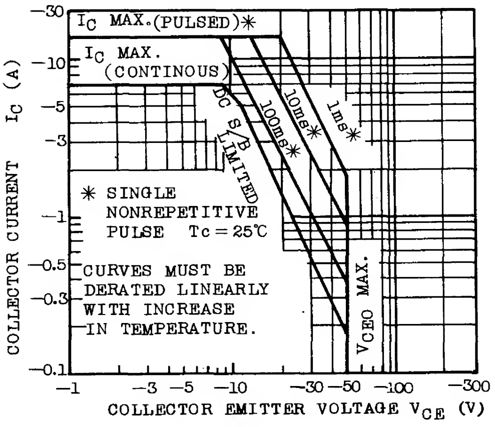
STATIC CHARACTERISTICS



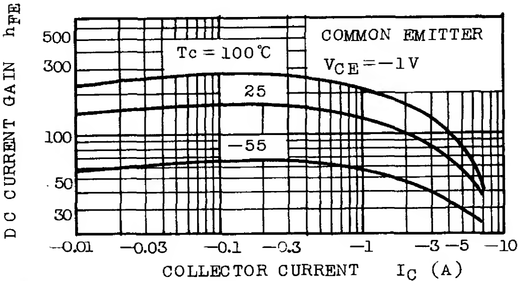
I_C − V_{BE}



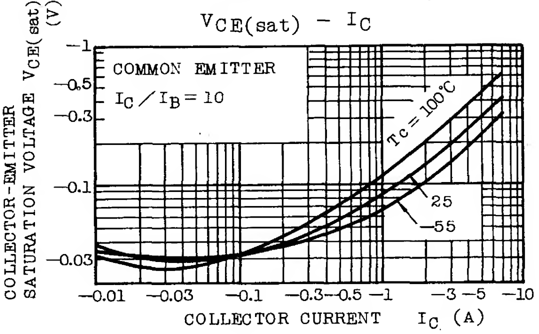
SAFE OPERATING AREA



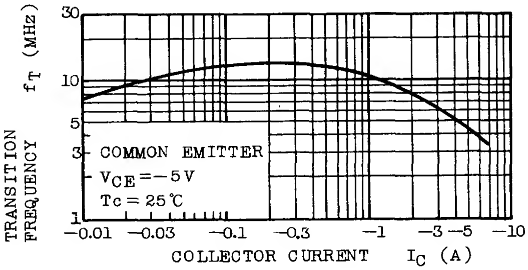
h_{FE} − I_C



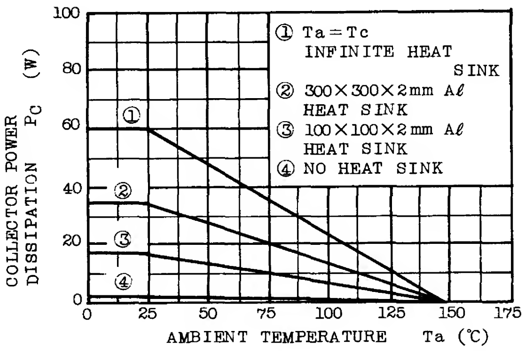
$V_{CE(sat)}$ − I_C



f_T − I_C



P_C − Ta

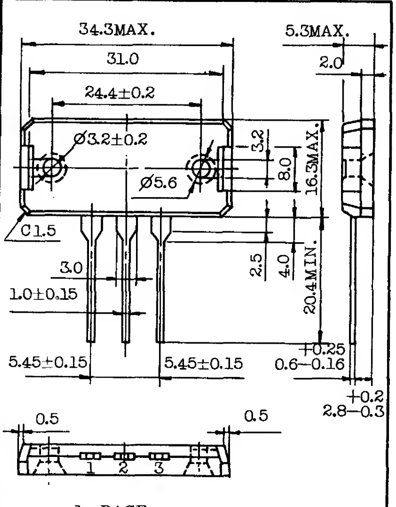


2SB755

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 34 A 1 A

Weight : 10.8g

FEATURES:

- High Breakdown Voltage : V_{CEO}=-150V (Min.)
- High Transition Frequency : f_T=20MHz (Typ.)
- Complementary to 2SD845.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

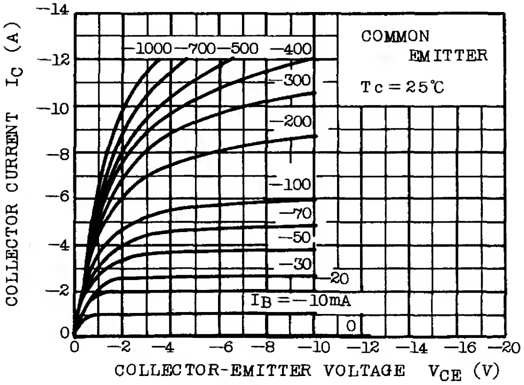
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-150	V
Collector-Emitter Voltage	V_{CEO}	-150	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-12	A
Emitter Current	I_E	12	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

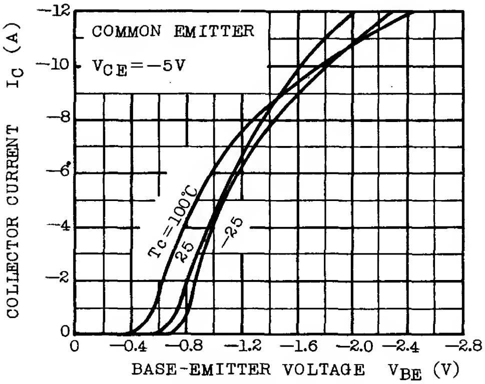
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-150V, I_E=0	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-0.1A, I_B=0	-150	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=-10mA, I_C=0	-5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5V, I_B=-0.5A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	-	20	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	450	-	pF

Note : h_{FE} Classification R : 55∿110, O : 80∿160

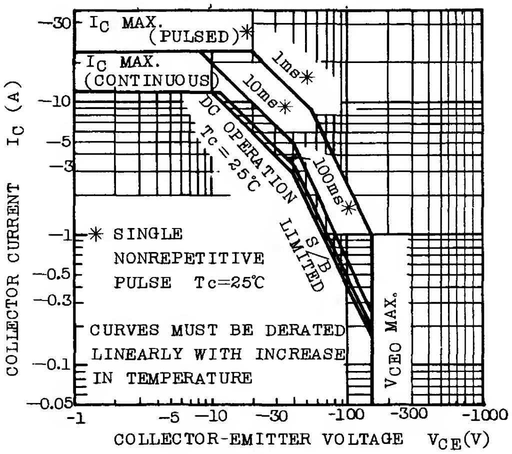
$I_C - V_{CE}$



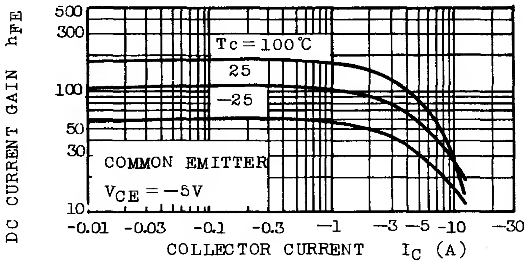
$I_C - V_{BE}$



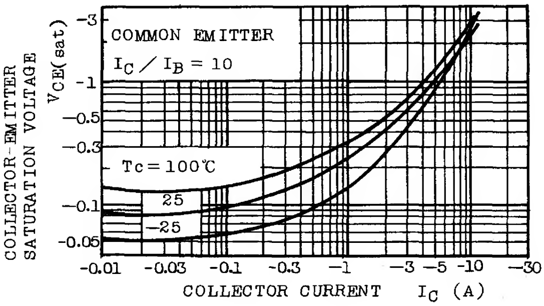
SAFE OPERATING AREA



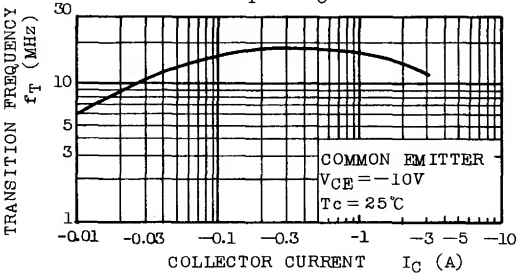
$h_{FE} - I_C$



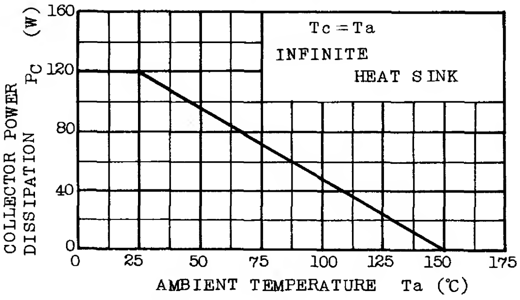
$V_{CE(sat)} - I_C$



$f_T - I_C$



$P_C - Ta$



2SB833

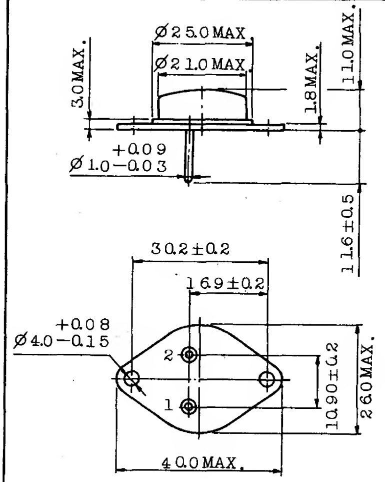
SILICON PNP TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- High Collector Current : I_C=-30A
- High DC Current Gain
  : $h_{FE(2)}$=1000(Min.) (V_{CE}=-5V, I_C=-20A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

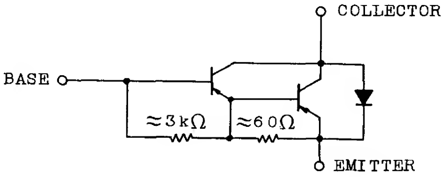
JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21A1A

Mounting kit No. AC73
Weight : 12.9g

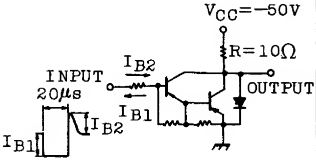
MAXIMUM RATINGS (Ta=25°C)

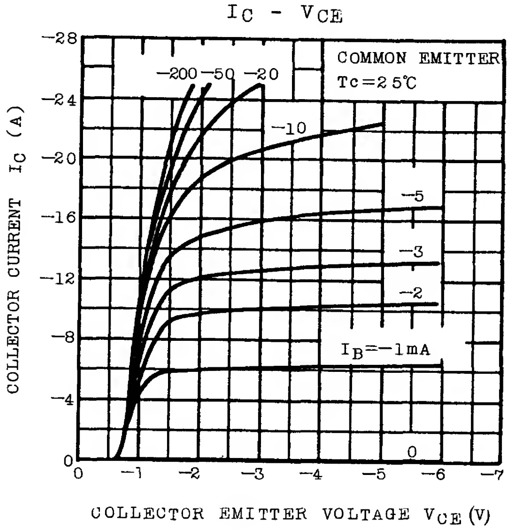
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-30	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

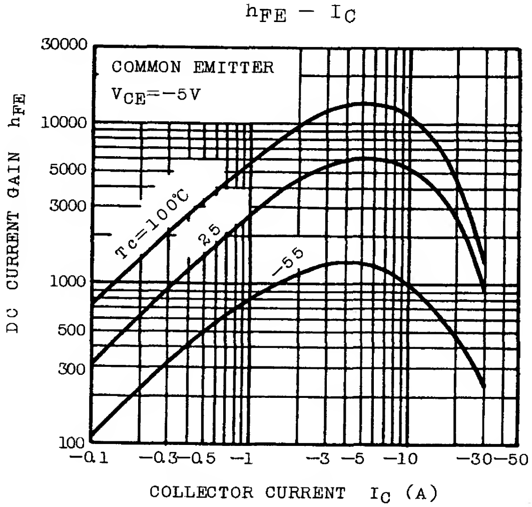
EQUIVALENT CIRCUIT

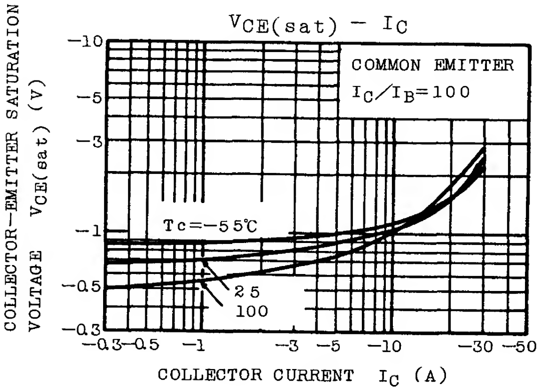


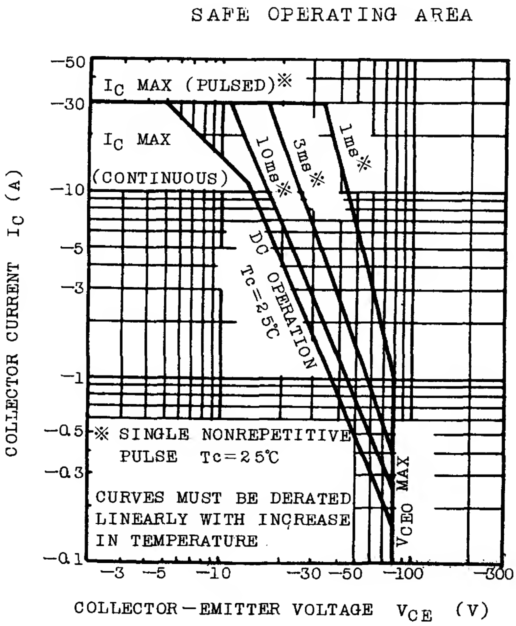
ELECTRICAL CHARACTERISTICS (Ta=25°C)

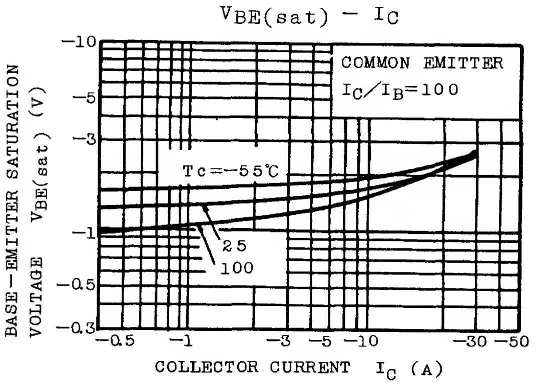
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-80V$, $I_E=0$	-	-	-100	µA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-10	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA$, $I_B=0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-5V$, $I_C=-20A$	1000	-	-	
		$h_{FE(2)}$	$V_{CE}=-5V$, $I_C=-30A$	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-20A$, $I_B=-0.2A$	-	-	-3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	-3.5	V
Emitter-Collector Forward Voltage		V_{ECF}	$I_E=-10A$, $I_B=0$	-	-	-3	V
Transition Frequency		f_T	$V_{CE}=-5V$, $I_C=-1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, $f=1MHz$	-	400	-	pF
Switching Time	Turn-on Time	t_{on}	 $V_{CC}=-50V$ R=10Ω INPUT 20µs I_{B2} I_{B1} I_{B2} I_{B1} OUTPUT $-I_{B1}=I_{B2}=0.01A$ DUTY CYCLE ≦ 1 %	-	1.5	-	µs
	Storage Time	t_{stg}		-	4	-	
	Fall Time	t_f		-	2	-	


IC - VCE
COMMON EMITTER
Tc=25℃
−200 −50 −20
−10
−5
−3
−2
IB=−1mA
0
−28
−24
−20
−16
−12
−8
−4
0
0
−1
−2
−3
−4
−5
−6
−7
COLLECTOR CURRENT IC (A)
COLLECTOR EMITTER VOLTAGE VCE (V)


hFE − IC
COMMON EMITTER
VCE=−5V
Tc=100℃
25
−55
30000
10000
5000
3000
1000
500
300
100
−0.1
−0.3
−0.5
−1
−3
−5
−10
−30
−50
DC CURRENT GAIN hFE
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC/IB=100
Tc=−55℃
25
100
−10
−5
−3
−1
−0.5
−0.3
−0.3
−0.5
−1
−3
−5
−10
−30
−50
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX
(CONTINUOUS)
1ms※
3ms※
10ms※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
−50
−30
−10
−5
−3
−1
−0.5
−0.3
−0.1
−3
−5
−10
−30
−50
−100
−300
COLLECTOR CURRENT IC (A)
COLLECTOR−EMITTER VOLTAGE VCE (V)


VBE(sat) − IC
COMMON EMITTER
IC/IB=100
Tc=−55℃
25
100
−10
−5
−3
−1
−0.5
−0.3
−0.5
−1
−3
−5
−10
−30
−50
BASE−EMITTER SATURATION VOLTAGE VBE(sat) (V)
COLLECTOR CURRENT IC (A)

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

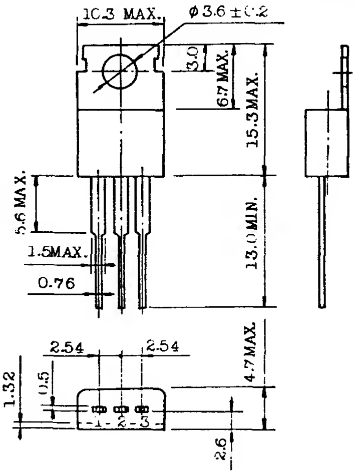
2SB834

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-1.0V(Max.) at I_C=-3A, I_B=-0.3A
- Collector Power Dissipation
  : P_C=30W (Tc=25°C)
- Complementary to 2SD880.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

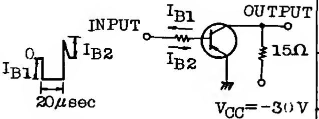
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

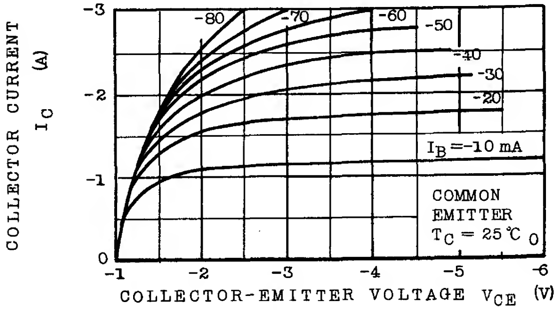
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-60V, I_E=0	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-0.5A	60	-	200	
		$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-0.5	-1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-5V, I_C=-0.5A	-	-0.7	-1.0	V
Transition Frequency		f_T	V_{CE}=-5V, I_C=-0.5A	-	9	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT IB1 IB2 0 IB1 IB2 15Ω 20μsec VCC=-30V $-I_{B1}=I_{B2}$=0.2A DUTY CYCLE≦1%	-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		-	0.5	-	

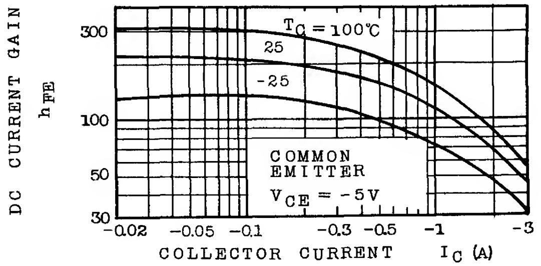
Note: $h_{FE(1)}$ Classification 0: 60∿120, Y: 100∿200

2SB834

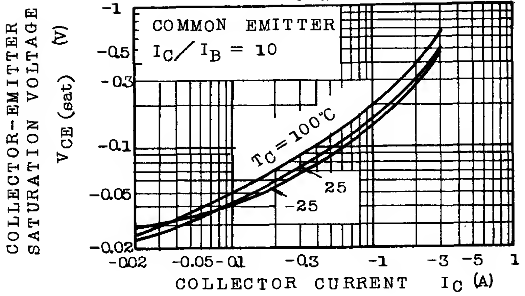
I_C – V_{CE}



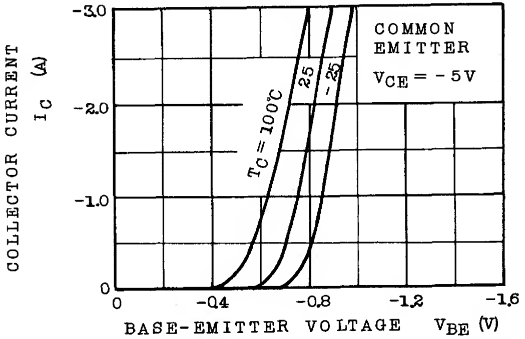
h_{FE} – I_C



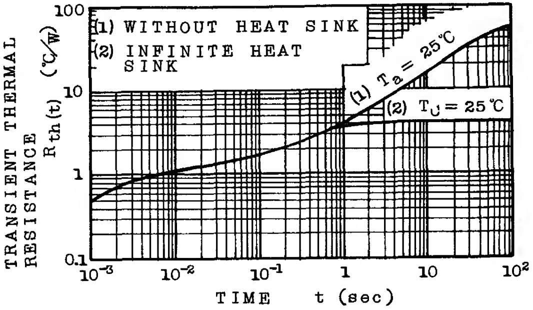
$V_{CE (sat)}$ – I_C



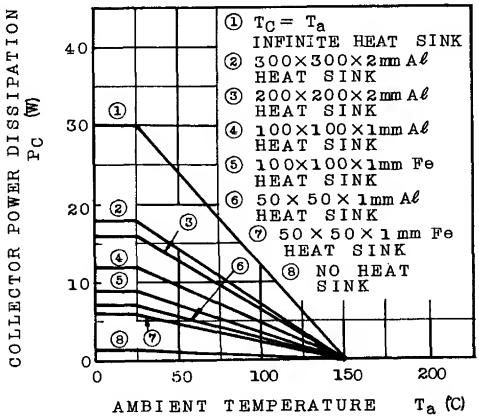
I_C – V_{BE}



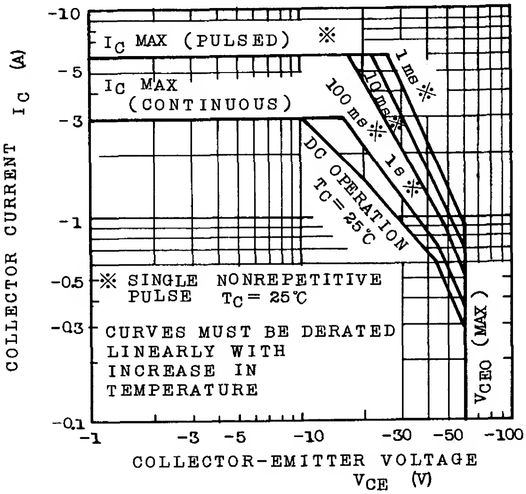
$R_{th(t)}$ – t



P_C – T_a



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

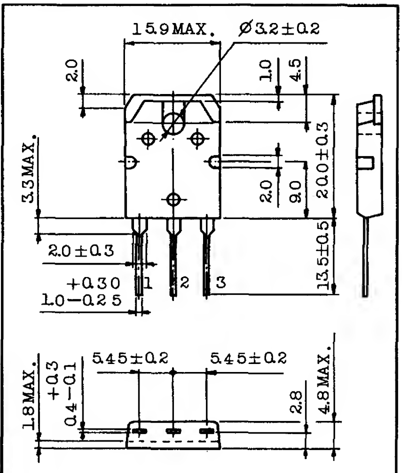
2SB863

o POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SD1148
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

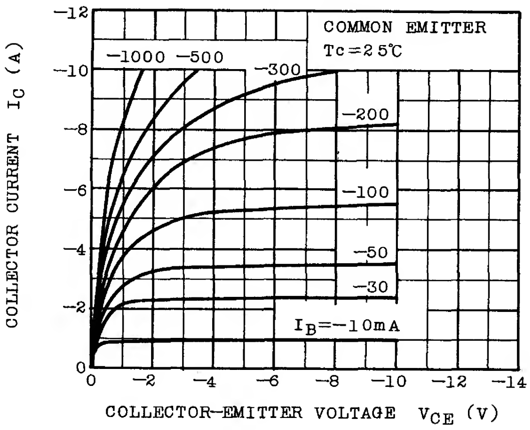
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-140	V
Collector-Emitter Voltage	V_{CEO}	-140	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-10	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

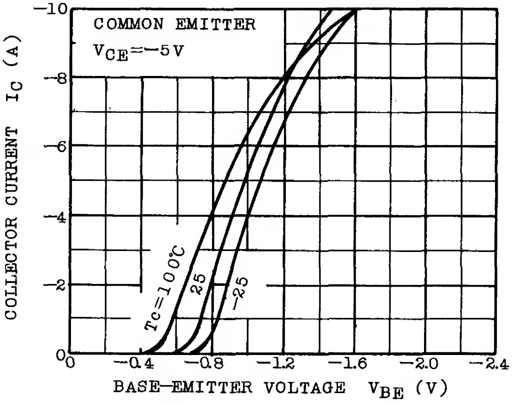
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-140V, I_E=0	-	-	-5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-140	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=-5V, I_C=-1A	55	-	160	
	$h_{FE}(2)$	V_{CE}=-5V, I_C=-5A	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-0.6	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-5A	-	-0.96	-1.5	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-1A	-	15	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	400	-	pF

Note: $h_{FE}(1)$ Classification R : 55~110 O : 80~160

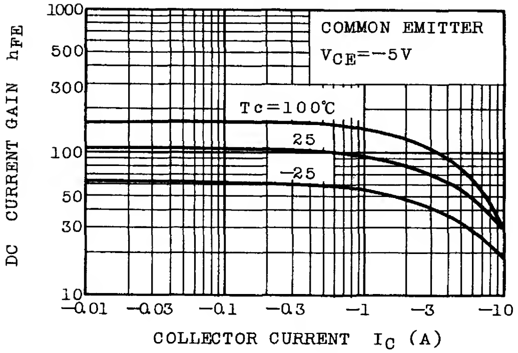
$I_C - V_{CE}$



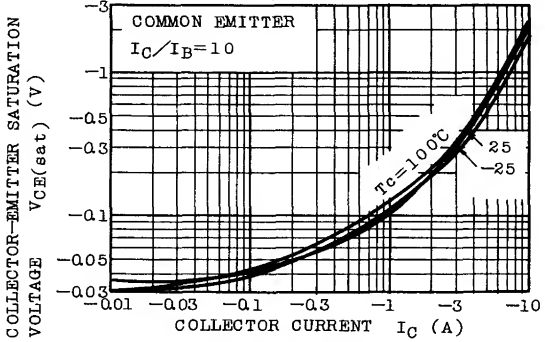
$I_C - V_{BE}$



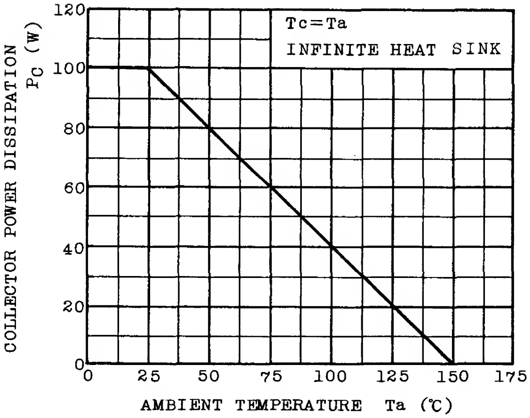
$h_{FE} - I_C$



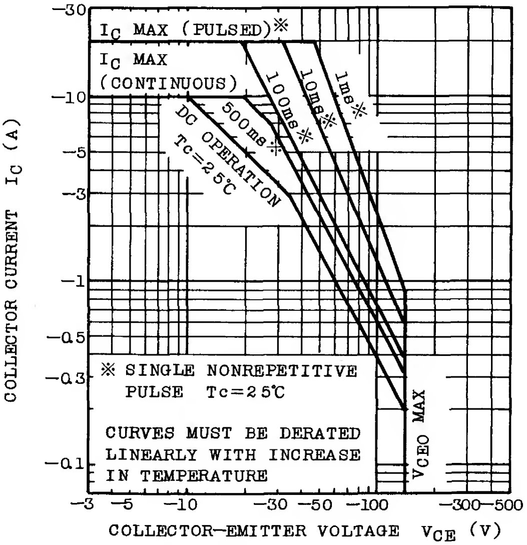
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA

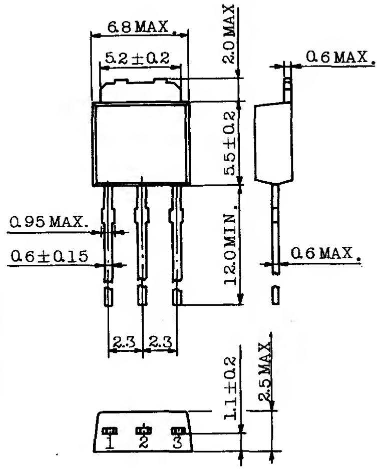


SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SB905

POWER AMPLIFIER APPLICATION.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2—7B1A

Weight : 0.36g

FEATURES:

- Complementary to 2SD1220

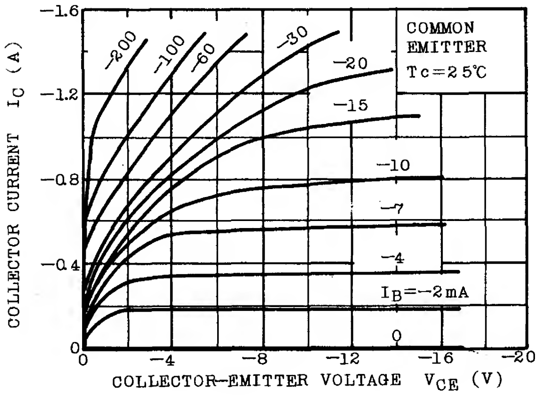
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-150	V
Collector-Emitter Voltage		V_{CEO}	-150	V
Emitter-Base Voltage		V_{EBO}	-6	V
Collector Current		I_C	-1.5	A
Base Current		I_B	-1.0	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	°C
Storage Temperature		T_{stg}	-55~150	°C

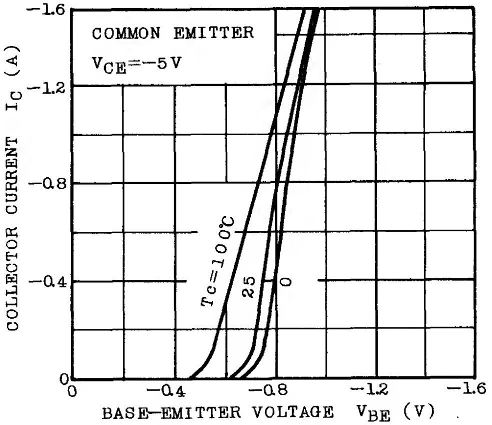
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-150V,\ I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-6V,\ I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10mA,\ I_B=0$	-150	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=-5V,\ I_C=-200mA$	60	-	320	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-500mA,\ I_B=-50mA$	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5V,\ I_C=-5mA$	-0.5	-	-0.8	V
Transition Frequency	f_T	$V_{CE}=-5V,\ I_C=-200mA$	15	50	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V,\ I_E=0,\ f=1MHz$	-	-	35	pF

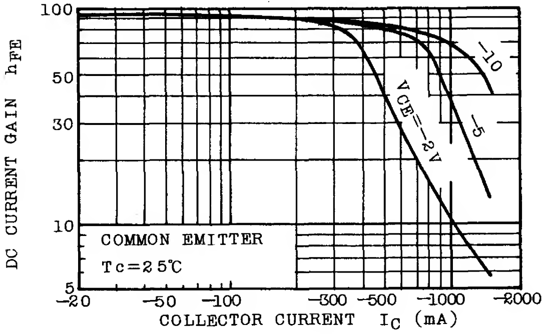
Note: h_{FE} Classification R : 60~120, O : 100~200, Y : 160~320



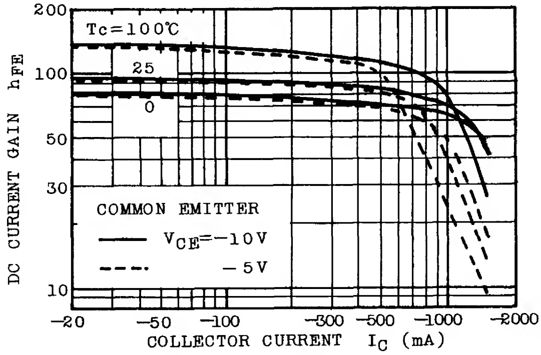
I_C – V_{CE}



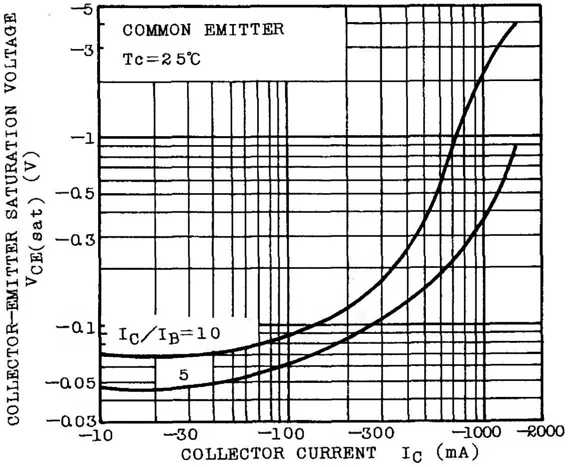
I_C – V_{BE}



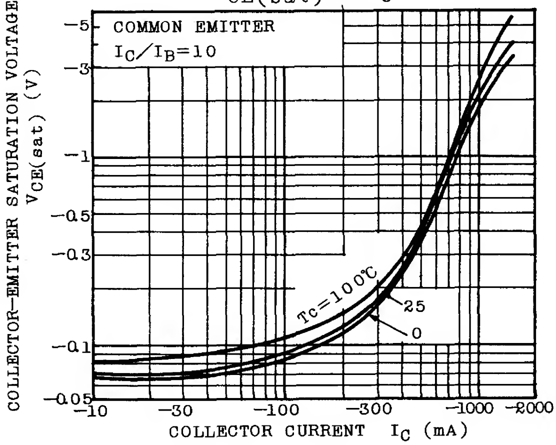
h_{FE} – I_C



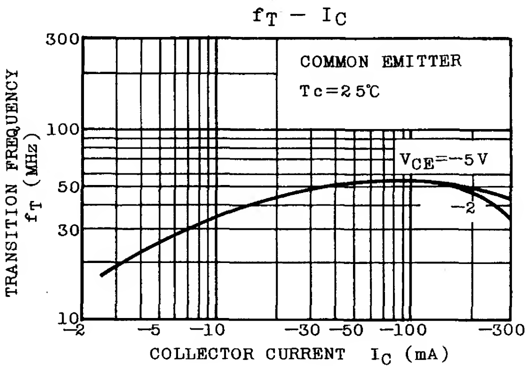
h_{FE} – I_C

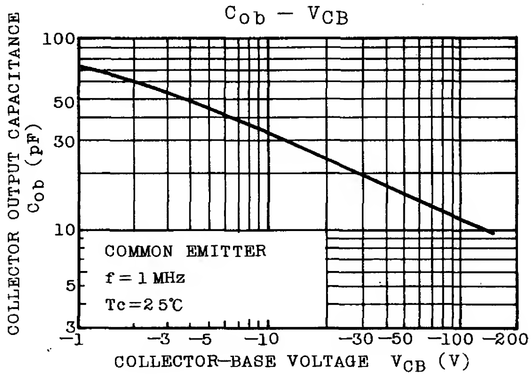


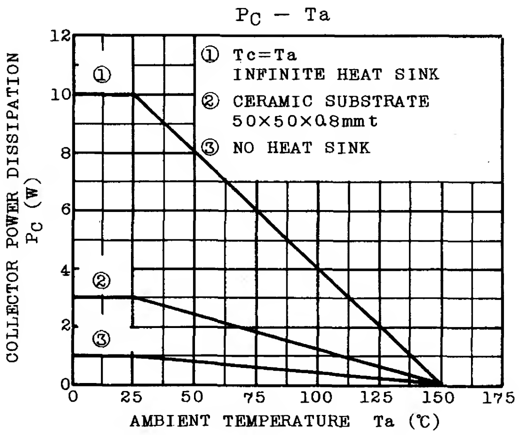
$V_{CE(sat)}$ – I_C

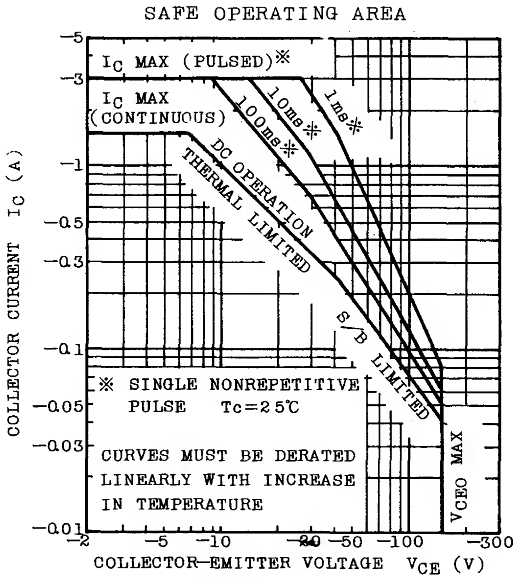


$V_{CE(sat)}$ – I_C


f_T — I_C
COMMON EMITTER
Tc=25℃
V_{CE}=−5V
−2
TRANSITION FREQUENCY f_T (MHz)
300
100
50
30
10
−2
−5
−10
−30
−50
−100
−300
COLLECTOR CURRENT I_C (mA)


C_{ob} — V_{CB}
COMMON EMITTER
f=1MHz
Tc=25℃
COLLECTOR OUTPUT CAPACITANCE C_{ob} (pF)
100
50
30
10
5
3
−1
−3
−5
−10
−30
−50
−100
−200
COLLECTOR–BASE VOLTAGE V_{CB} (V)


P_C — Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION P_C (W)
12
10
8
6
4
2
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
I_C MAX (PULSED)※
I_C MAX (CONTINUOUS)
1ms※
10ms※
100ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
V_{CEO} MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT I_C (A)
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
−2
−5
−10
−30
−50
−100
−300
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

2SB906

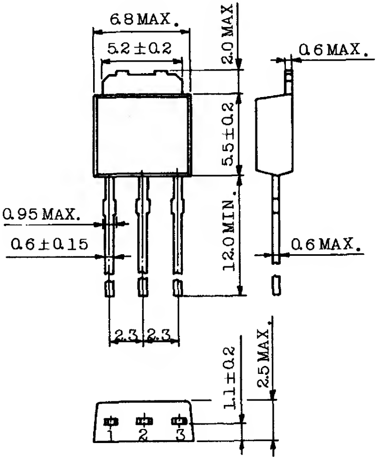
SILICON PNP TIRPLE DIFFUSED TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-1.0V(Typ.) (I_C=-3A, I_B=-0.3A)
- High Power Dissipation : P_C=20W (Tc=25°C)
- Complementary to 2SD1221

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

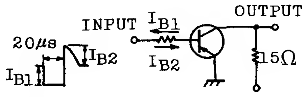
JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

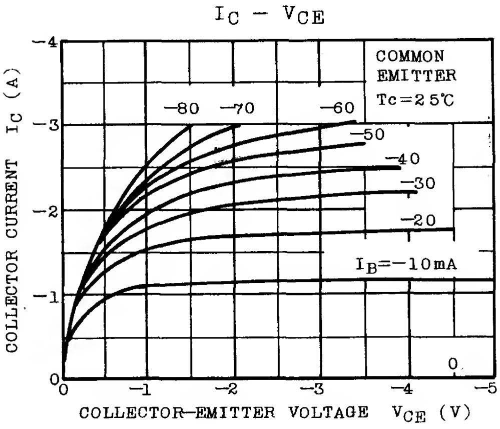
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature		T_{stg}	-55～155	°C

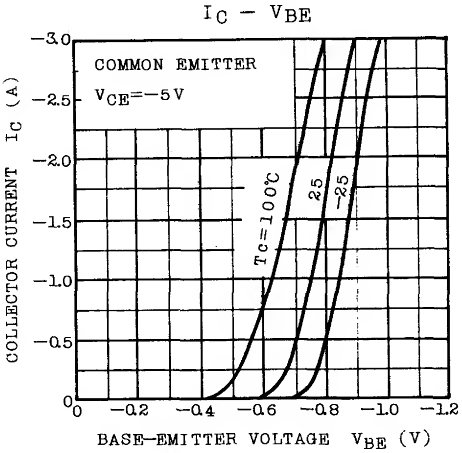
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-60V, I_E=0	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-0.5A	60	-	200	
		$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-1.0	-1.7	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-5V, I_C=-0.5A	-	-1.0	-1.5	V
Transition Frequency		f_T	V_{CE}=-5V, I_C=-0.5A	-	9	-	MHz
Collector Output Capacitance		Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B1} OUTPUT 20μs I_{B2} I_{B1} I_{B2} 15Ω V_{CC}=−30V $-I_{B1}=I_{B2}$=0.2A DUTY CYCLE≦1%	-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		-	0.5	-	

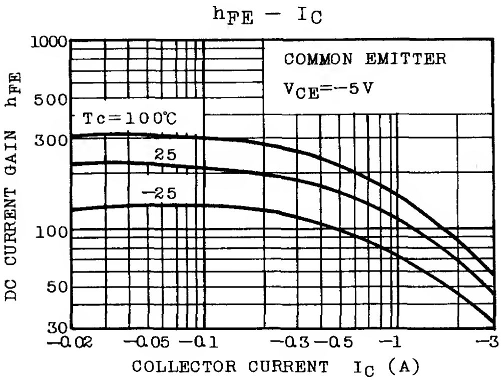
Note : h_{FE} Classification O : 60～120, Y : 100～200



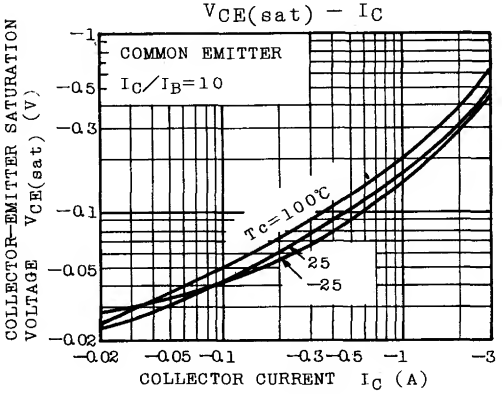
I_C – V_{CE}



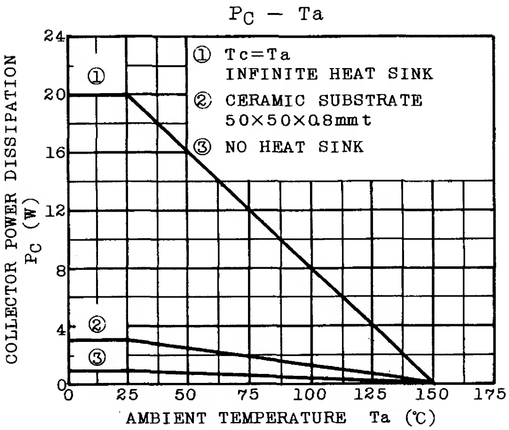
I_C – V_{BE}



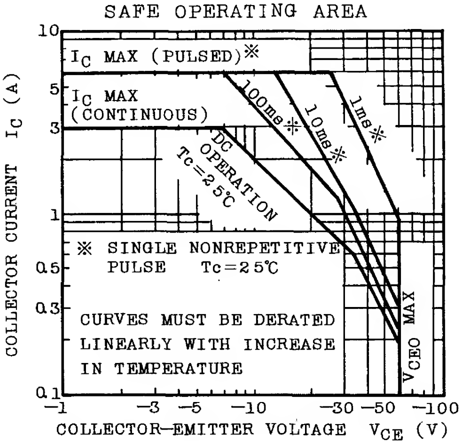
h_{FE} – I_C



$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA

2SB907

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

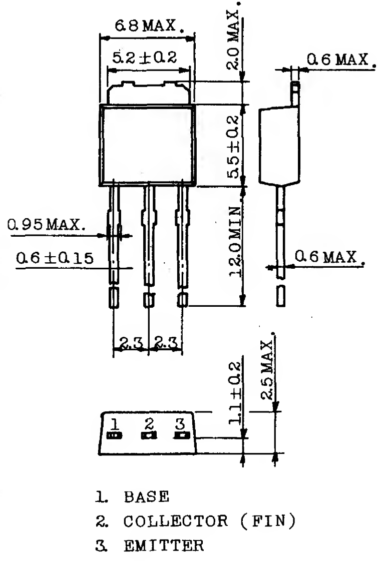
FEATURES:

- High DC Current Gain
  : $h_{FE(1)}=2000$(Min.) ($V_{CE}=-2$V, $I_C=-1$A)
- Low Saturation Voltage
  : $V_{CE(sat)}=-1.5$V(Max.) ($I_C=-2$A)
- Complementary to 2SD1222.

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-40	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.3	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.0	W
	$Tc=25^{\circ}C$		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

Unit in mm

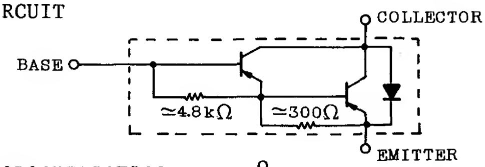


1. BASE
2. COLLECTOR (FIN)
3. EMITTER

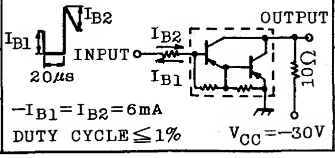
JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

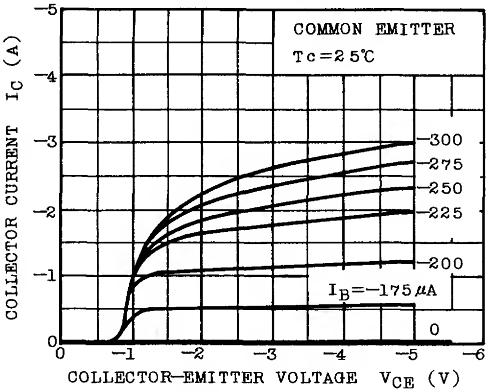
Weight : 0.36g

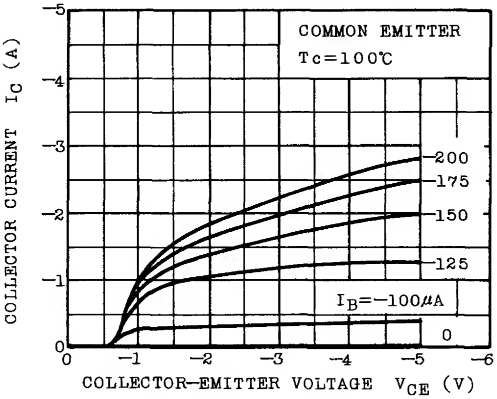
EQUIVALENT CIRCUIT

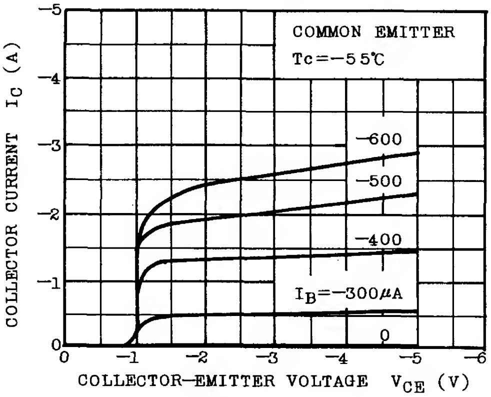


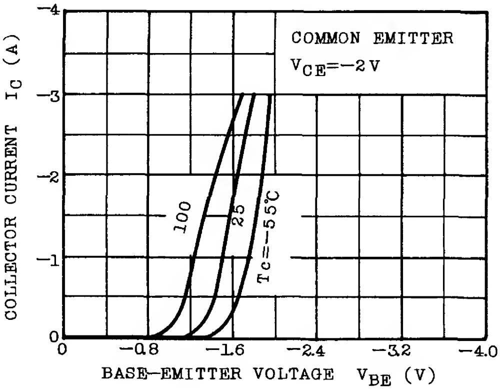
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

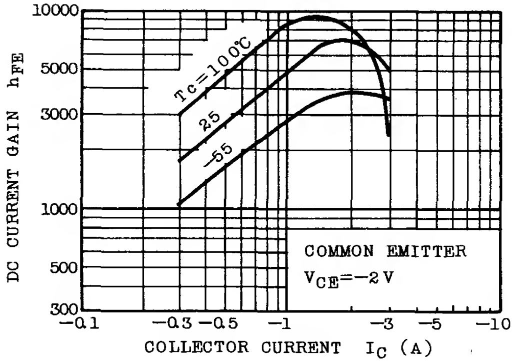
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-60$V, $I_E=0$	-	-	-20	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5$V, $I_C=0$	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-25$mA, $I_B=0$	-40	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-2$V, $I_C=-1$A	2000	-	-	
		$h_{FE(2)}$	$V_{CE}=-2$V, $I_C=-3$A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-2$A, $I_B=-4$mA	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-2$A, $I_B=-4$mA	-	-	-2.0	
Switching Time	Turn-on Time	t_{on}	 I_{B2} I_{B1} INPUT 20μs I_{B2} I_{B1} OUTPUT 10Ω $V_{CC}=-30$V $-I_{B1}=I_{B2}=6$mA DUTY CYCLE≦1%	-	0.30	-	μs
	Storage Time	t_{stg}		-	0.60	-	
	Fall Time	t_f		-	0.25	-	

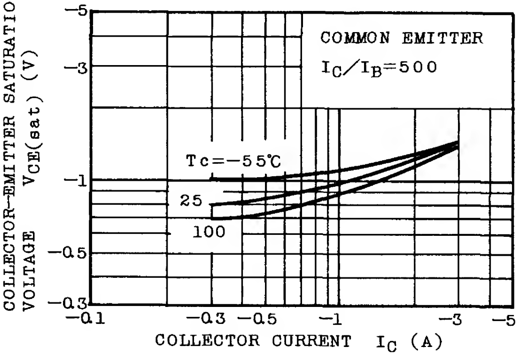

$I_C - V_{CE}$

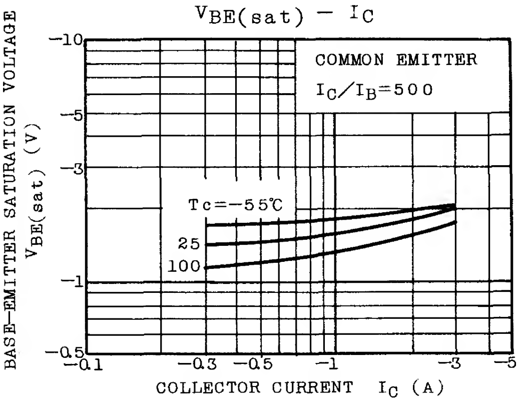

$I_C - V_{CE}$

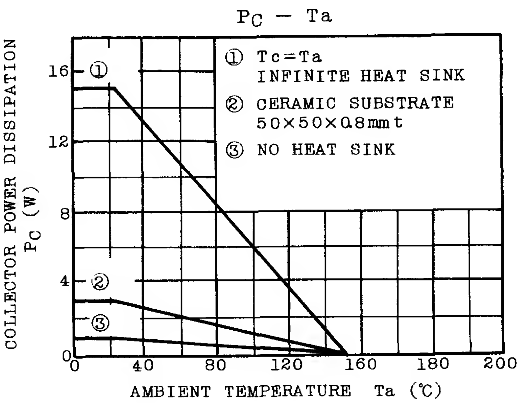

$I_C - V_{CE}$

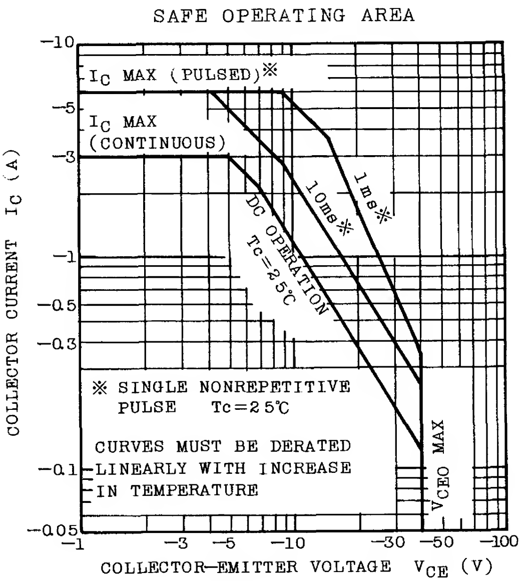

$I_C - V_{BE}$


$h_{FE} - I_C$


$V_{CE(sat)} - I_C$


VBE(sat) — IC
COMMON EMITTER
IC/IB=500
Tc=−55℃
25
100
BASE−EMITTER SATURATION VOLTAGE VBE(sat) (V)
−10
−5
−3
−1
−0.5
−0.1
−0.3
−0.5
−1
−3
−5
COLLECTOR CURRENT IC (A)


PC — Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
COLLECTOR POWER DISSIPATION PC (W)
16
12
8
4
0
①
②
③
0
40
80
120
160
180
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION Tc=25°C
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−1
−3
−5
−10
−30
−50
−100
COLLECTOR−EMITTER VOLTAGE VCE (V)

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

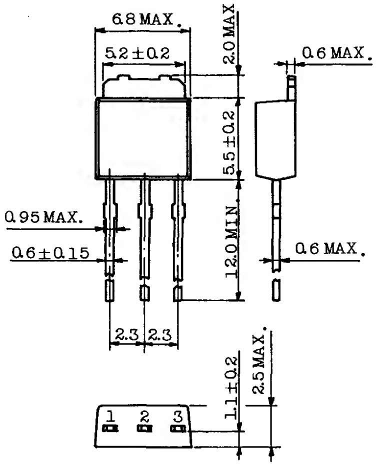
2SB908

SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : $h_{FE(1)}$=2000(Min.) (V_{CE}=-2V, I_C=-1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=-1.5(Max.) (I_C=-3A)
- Complementary to 2SD1223.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

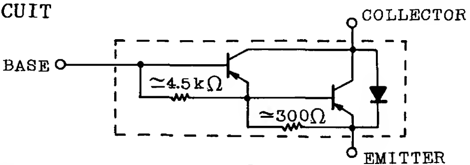
JEDEC	—
EIAJ	—
TOSHIBA	2—7B1A

Weight : 0.36g

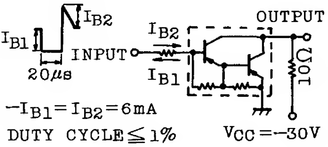
MAXIMUM RATINGS (Ta=25°C)

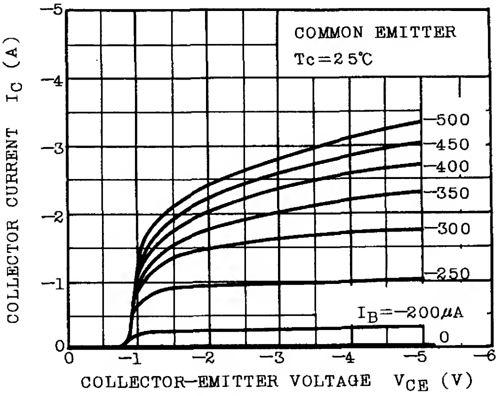
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-4	A
Base Current		I_B	-0.4	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

EQUIVALENT CIRCUIT

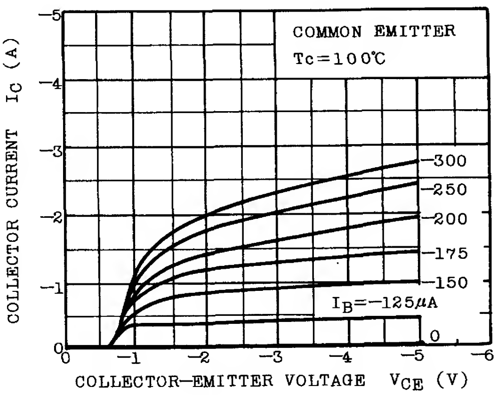


ELECTRICAL CHARACTERISTICS (Ta=25°C)

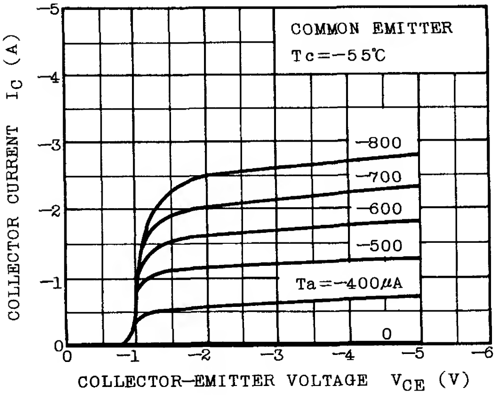
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-3A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-3A, I_B=-6mA	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-3A, I_B=-6mA	-	-	-2.0	
Switching Time	Turn-on Time	t_{on}	 I_{B2} I_{B1} 20μs I_{B2} INPUT I_{B1} OUTPUT 10Ω $-I_{B1}=I_{B2}$=6mA DUTY CYCLE≦1% V_{CC}=-30V	-	0.15	-	μs
	Storage Time	t_{stg}		-	0.80	-	
	Fall Time	t_f		-	0.40	-	



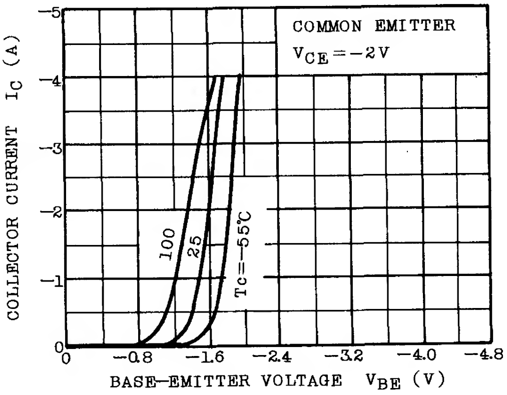
$I_C - V_{CE}$



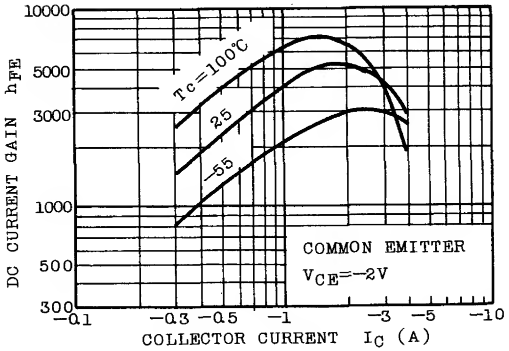
$I_C - V_{CE}$



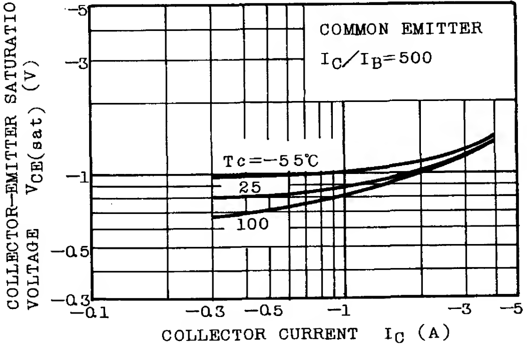
$I_C - V_{CE}$



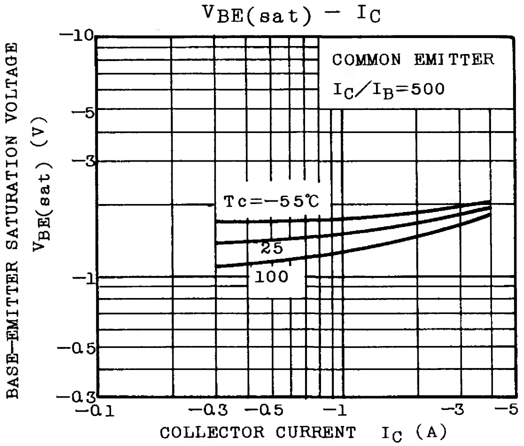
$I_C - V_{BE}$

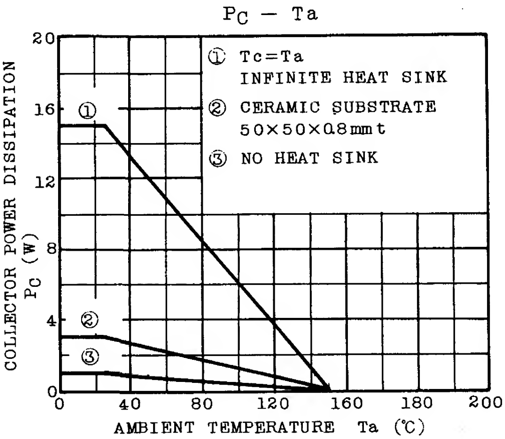


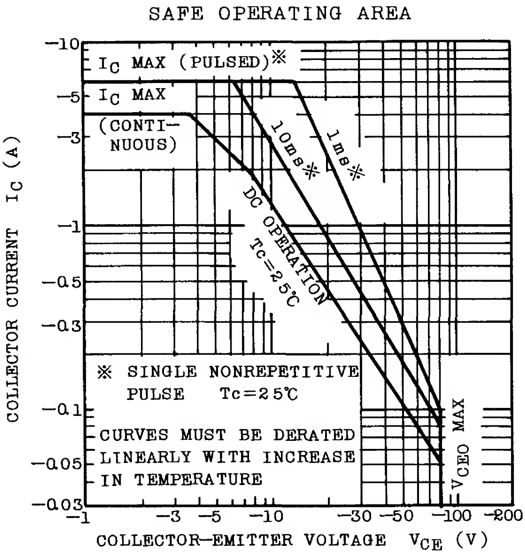
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$


VBE(sat) — IC
COMMON EMITTER
IC/IB=500
Tc=−55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.3
−0.5
−1
−3
−5
COLLECTOR CURRENT IC (A)


PC — Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
20
16
12
8
4
0
0
40
80
120
160
180
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTI-NUOUS)
10ms※
1ms※
DC OPERATION Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−1
−3
−5
−10
−30
−50
−100
−200
COLLECTOR-EMITTER VOLTAGE VCE (V)

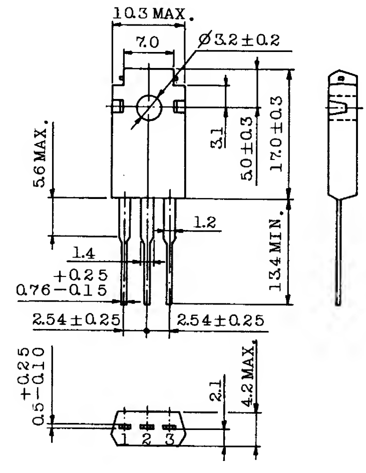
2SB992

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2–10K1A

Weight : 2.0g

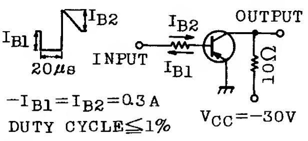
FEATURES:

- High Collector Current : I_C=-7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.5V(Max.) (at I_C=-4A)
- High Collector Power Dissipation
  : P_C=40W (at Tc=25°C)
- Complementary to 2SD1362

MAXIMUM RATINGS (Ta=25°C)

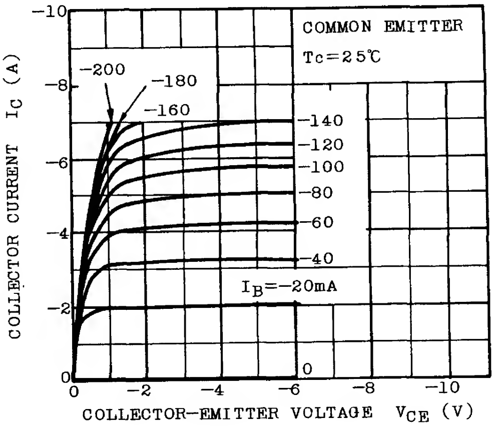
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

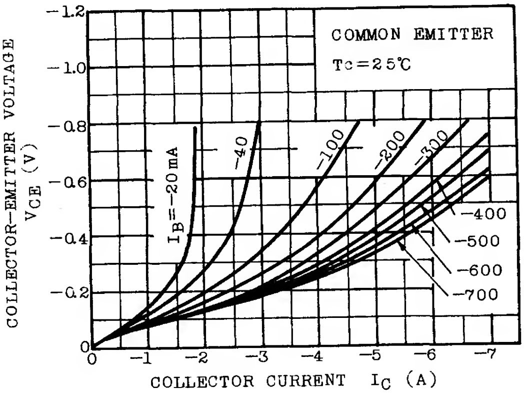
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=-4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.9	-1.4	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 IB1 IB2 20μs INPUT IB2 IB1 OUTPUT 10Ω −IB1=IB2=0.3A DUTY CYCLE≦1% VCC=−30V	-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

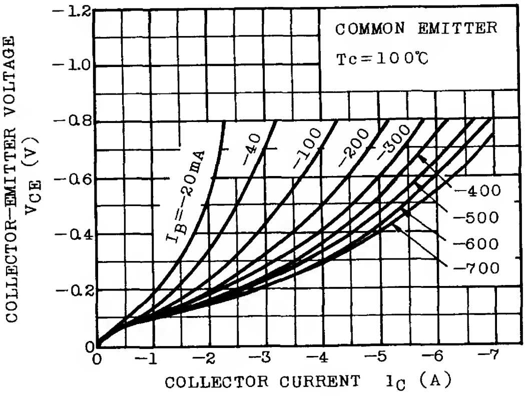
$I_C - V_{CE}$



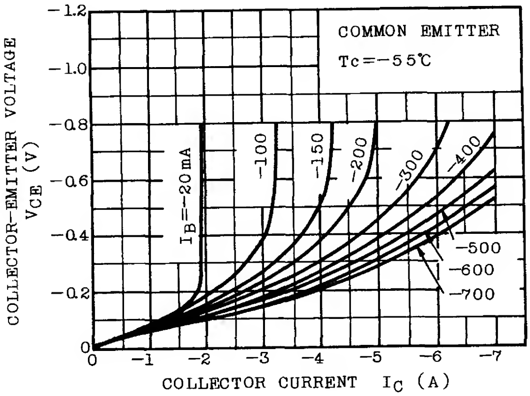
$V_{CE} - I_C$



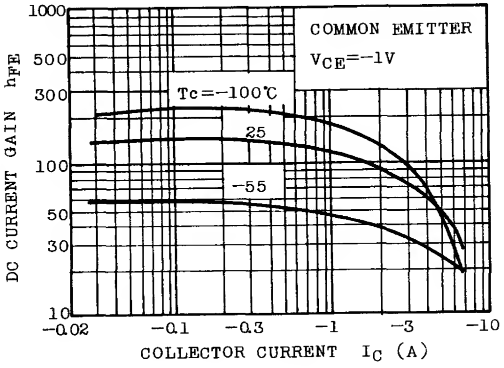
$V_{CE} - I_C$



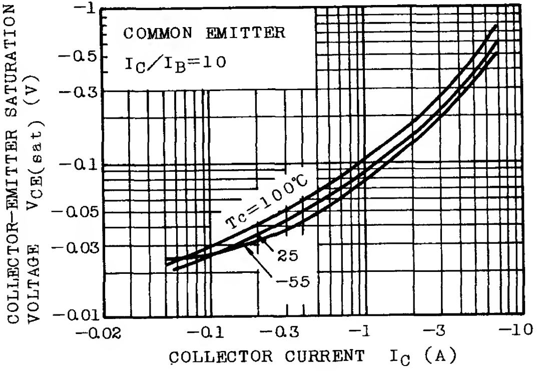
$V_{CE} - I_C$

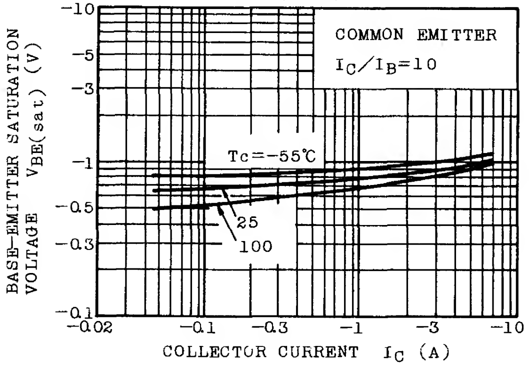


$h_{FE} - I_C$

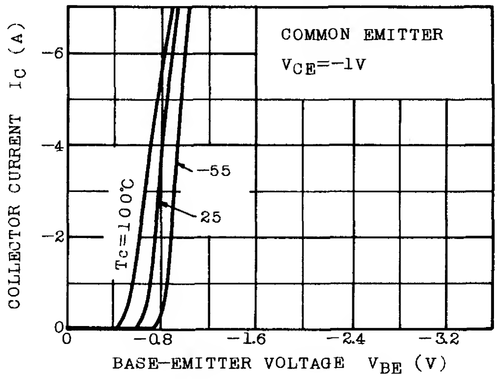


$V_{CE(sat)} - I_C$

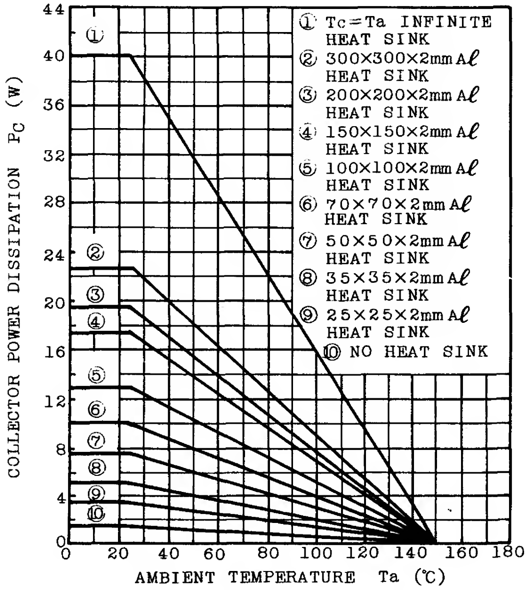




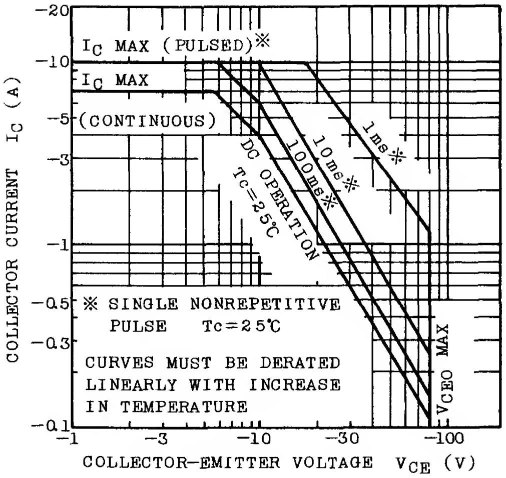
$V_{BE(sat)}$ — I_C



I_C — V_{BE}



P_C — Ta



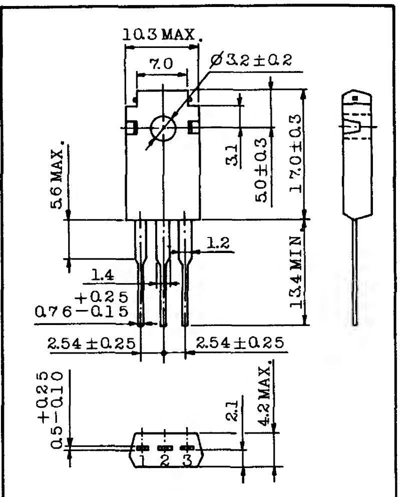
SAFE OPERATING AREA

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

2SB993

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

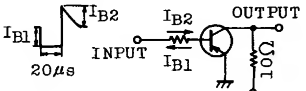
Weight : 2.0g

FEATURES:
- High Collector Current : I_C=−7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=−0.4V(Max.) (at I_C=−4A)
- High Collector Power Dissipation
  : P_C=40W (at Tc=25°C)
- Complementary to 2SD1363

MAXIMUM RATINGS (Ta=25°C)

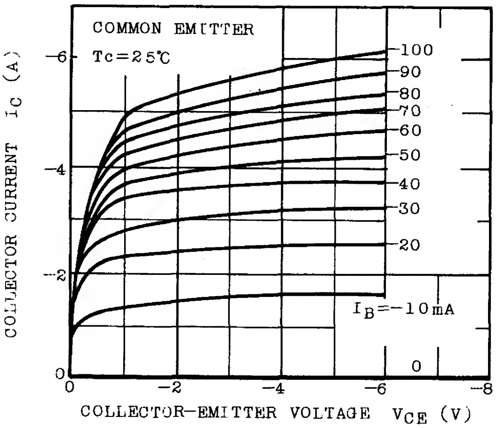
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	−70	V
Collector-Emitter Voltage		V_{CEO}	−50	V
Emitter-Base Voltage		V_{EBO}	−5	V
Collector Current		I_C	−7	A
Base Current		I_B	−1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

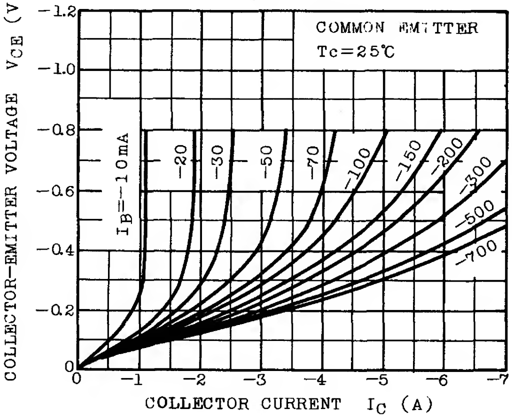
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=−70V, I_E=0	-	-	−30	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=−5V, I_C=0	-	-	−50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=−50mA, I_B=0	−50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=−1V, I_C=−1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=−1V, I_C=−4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=−4A, I_B=−0.4A	-	−0.2	−0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=−4A, I_B=−0.4A	-	−0.9	−1.2	
Transition Frequency		f_T	V_{CE}=−4V, I_C=−1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=−10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1} I_{B2} 20μs INPUT I_{B2} I_{B1} OUTPUT 10Ω $-I_{B1}=I_{B2}$=0.3A DUTY CYCLE≦1% V_{CC}=−30V	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

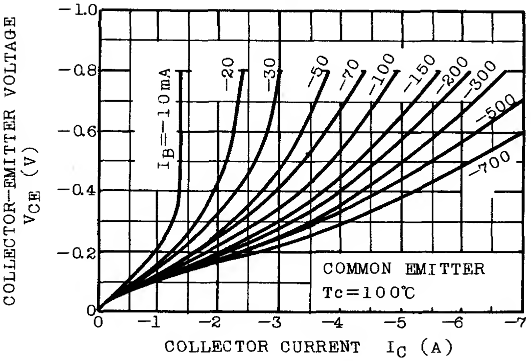
$I_C - V_{CE}$



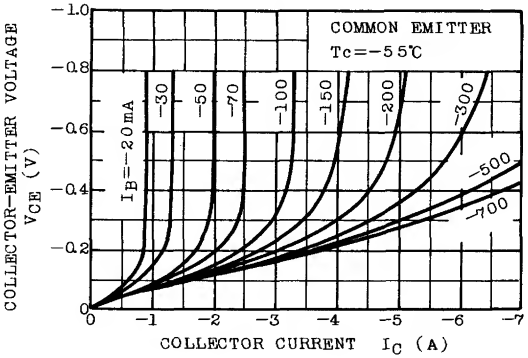
$V_{CE} - I_C$



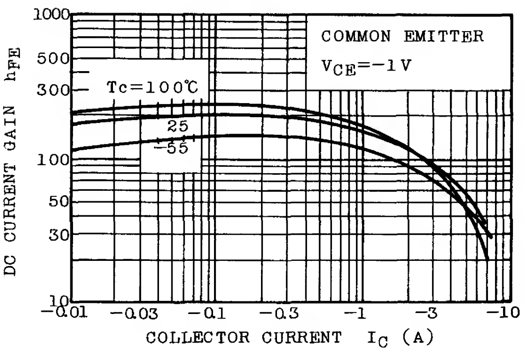
$V_{CE} - I_C$



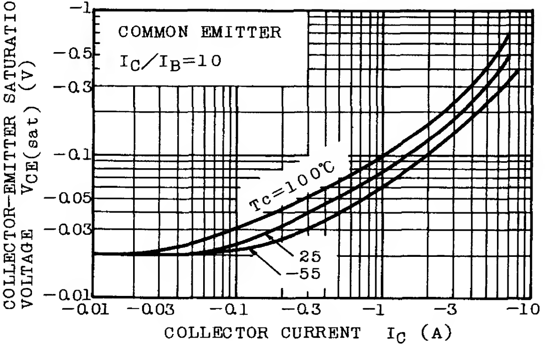
$V_{CE} - I_C$

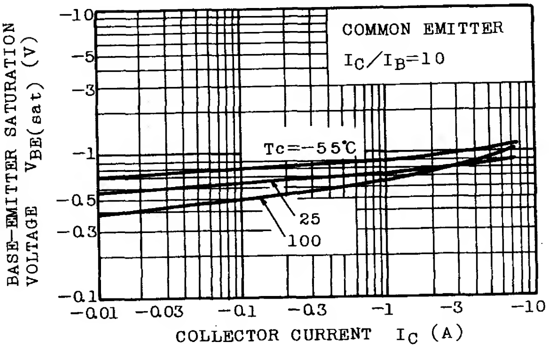


$h_{FE} - I_C$

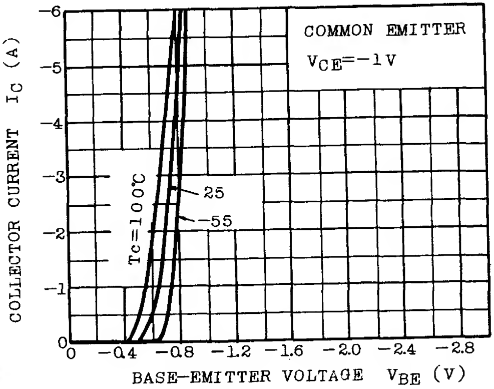


$V_{CE(sat)} - I_C$

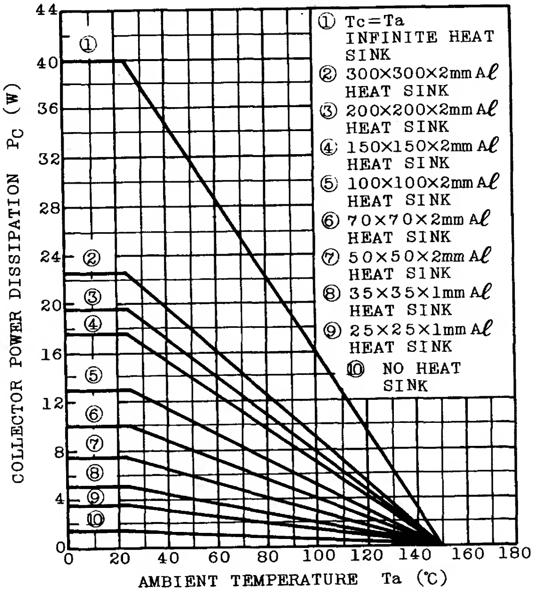




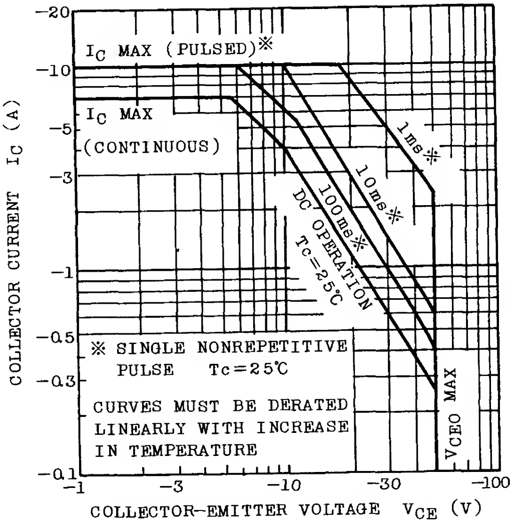
$V_{BE(sat)}$ – I_C



I_C – V_{BE}



P_C – Ta



SAFE OPERATING AREA

2SB994

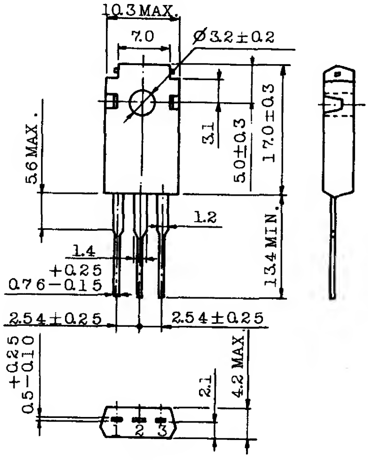
SILICON PNP TRIPLE DIFFUSED TYPE

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-1.0V$(Max.) at $I_C=-3A$, $I_B=-0.3A$
- Collector Power Dissipation : $P_C=30W$ ($Tc=25^{\circ}C$)
- Complementary to 2SD1354

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

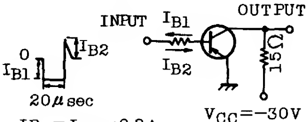
JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

Weight : 2.0g

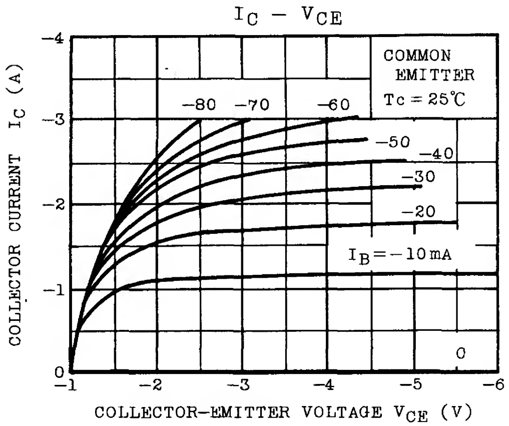
MAXIMUM RATINGS ($Ta=25^{\circ}C$)

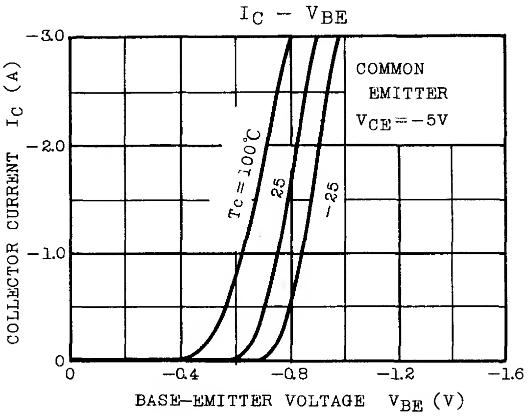
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.5	W
	$Tc=25^{\circ}C$		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

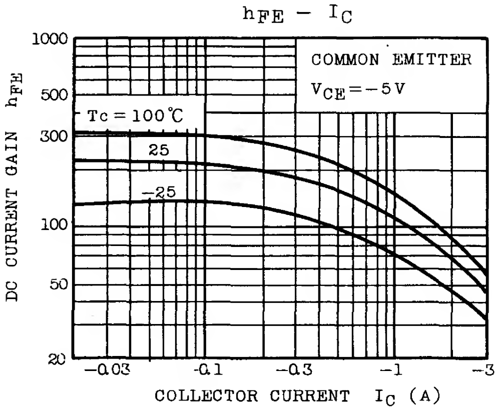
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

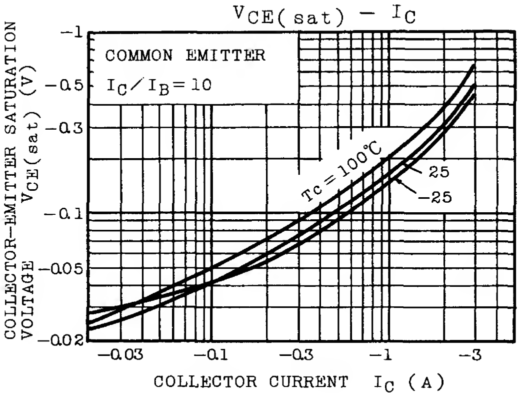
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-60V$, $I_E=0$	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-7V$, $I_C=0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA$, $I_B=0$	-60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-5V$, $I_C=-0.5A$	60	-	200	-
		$h_{FE(2)}$	$V_{CE}=-5V$, $I_C=-3A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-3A$, $I_B=-0.3A$	-	-0.5	-1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=-5V$, $I_C=-0.5A$	-	-0.7	-1.0	V
Transition Frequency		f_T	$V_{CE}=-5V$, $I_C=-0.5A$	-	9	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B1} OUTPUT 0 I_{B2} I_{B1} I_{B2} 15Ω 20μsec $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.2A$ DUTY CYCLE≦1%	-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		-	0.5	-	

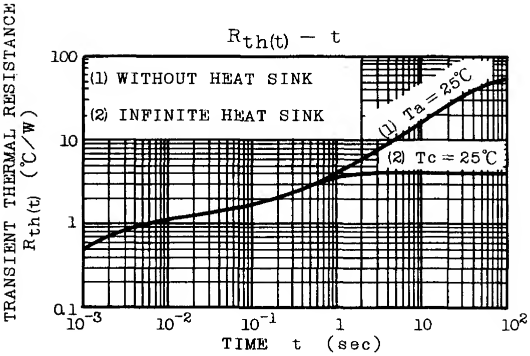
Note : $h_{FE(1)}$ Classification O : 60～120, Y : 100～200

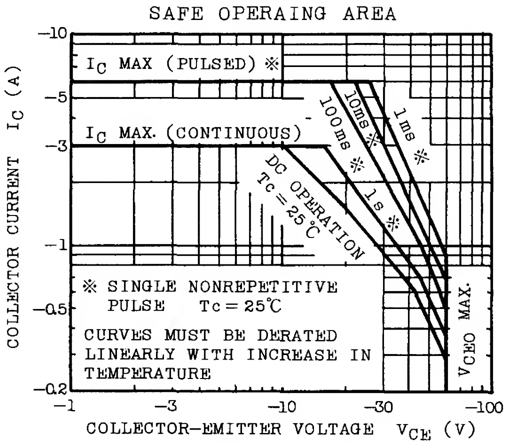

I_C – V_{CE}
COMMON EMITTER
Tc = 25℃
−80
−70
−60
−50
−40
−30
−20
I_B = −10 mA
0
COLLECTOR CURRENT I_C (A)
−4
−3
−2
−1
0
−1
−2
−3
−4
−5
−6
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


I_C – V_{BE}
COMMON EMITTER
V_{CE} = −5V
Tc = 100℃
25
−25
COLLECTOR CURRENT I_C (A)
−3.0
−2.0
−1.0
0
0
−0.4
−0.8
−1.2
−1.6
BASE-EMITTER VOLTAGE V_{BE} (V)


h_{FE} – I_C
COMMON EMITTER
V_{CE} = −5 V
Tc = 100℃
25
−25
DC CURRENT GAIN h_{FE}
1000
500
300
100
50
20
−0.03
−0.1
−0.3
−1
−3
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B = 10
Tc = 100℃
25
−25
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−1
−0.5
−0.3
−0.1
−0.05
−0.02
−0.03
−0.1
−0.3
−1
−3
COLLECTOR CURRENT I_C (A)


$R_{th(t)}$ – t
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1) Ta = 25℃
(2) Tc = 25℃
TRANSIENT THERMAL RESISTANCE $R_{th(t)}$ (℃/W)
100
10
1
0.1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
TIME t (sec)


SAFE OPERAING AREA
I_C MAX (PULSED) ※
I_C MAX. (CONTINUOUS)
10ms ※
1ms ※
100ms ※
1s ※
DC OPERATION Tc = 25℃
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
−10
−5
−3
−1
−0.5
−0.2
−1
−3
−10
−30
−100
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

2SB995

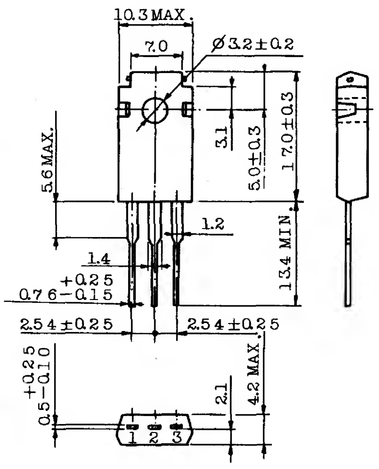
SILICON PNP TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=-100V
- Low Collector-Emitter Saturation Voltage
  : $V_{CE(sat)}$=-2.0V(Max.)
- Complementary to 2SD1355
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-10K1A

Weight : 2.0g

MAXIMUM RATINGS (T_a=25°C)

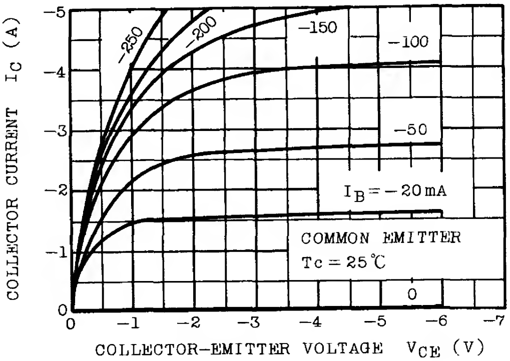
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-0.5	A
Collector Power Dissipation (T_c=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARCTERISTICS (T_a=25°C)

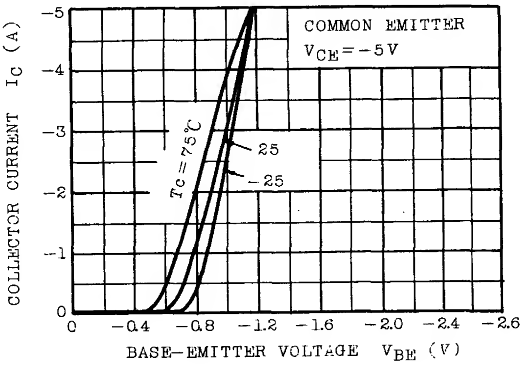
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	5	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

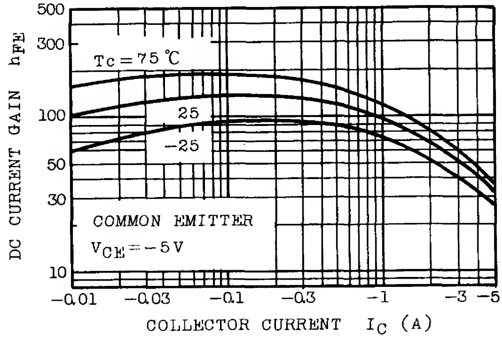
$I_C - V_{CE}$



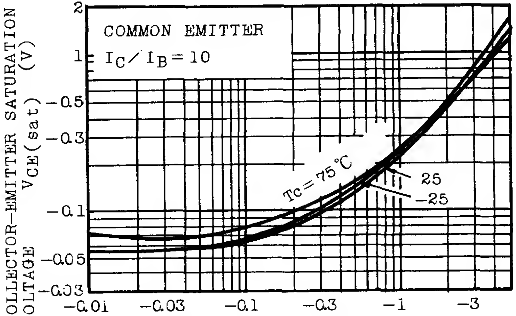
$I_C - V_{BE}$



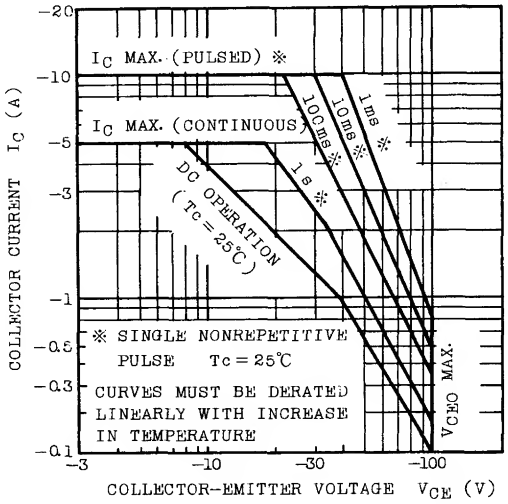
$h_{FE} - I_C$



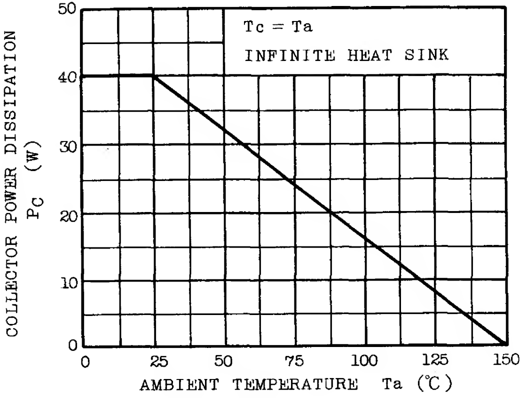
$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



$P_C - Ta$

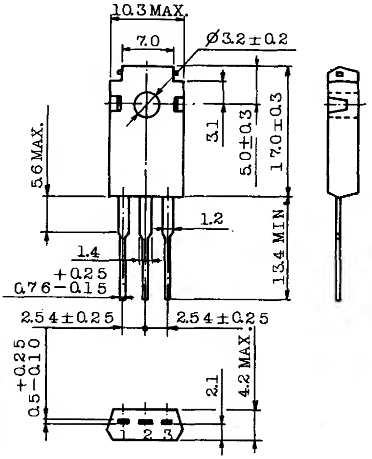


2SB996

SILICON PNP TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-10K1A

Weight : 2.0g

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SD1356
- Recommended for 20～25W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

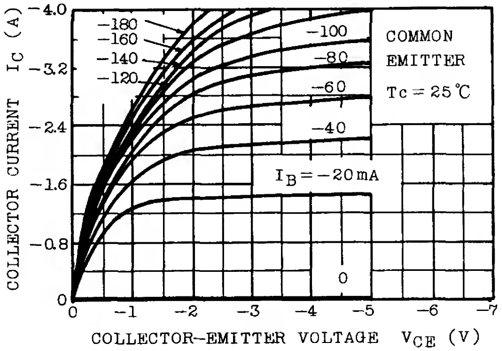
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-4	A
Base Current	I_B	-0.4	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

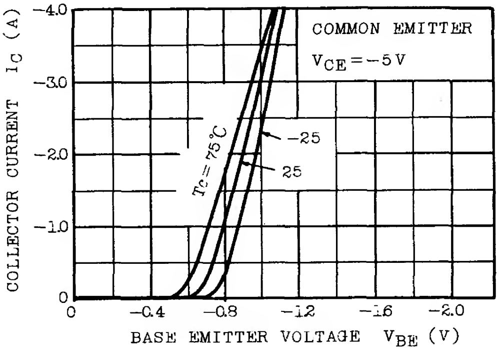
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-80V, I_E=0	-	-	-30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-3A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-0.5A	-	9	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

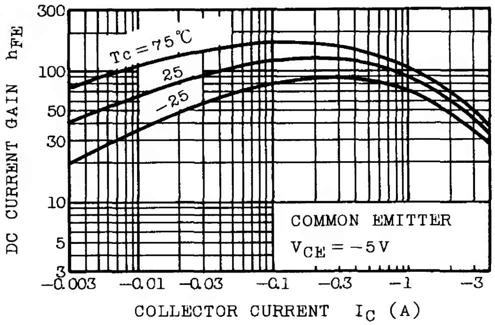
$I_C - V_{CE}$



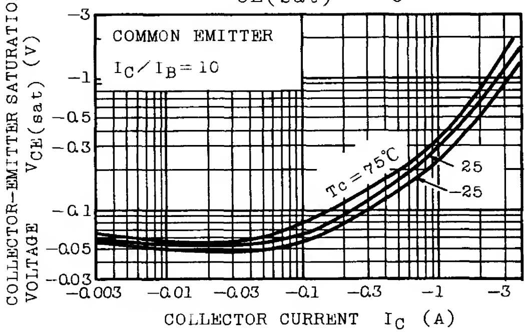
$I_C - V_{BE}$



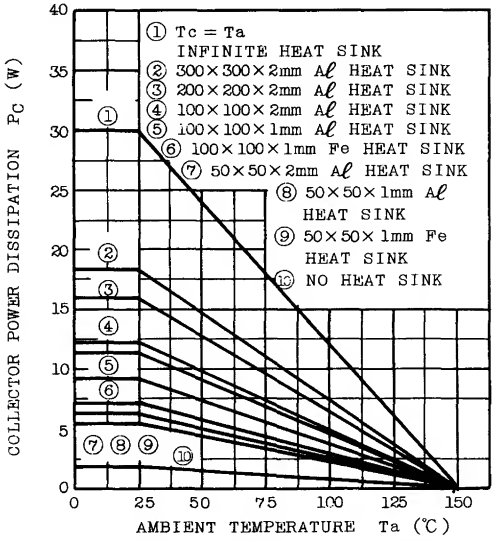
$h_{FE} - I_C$



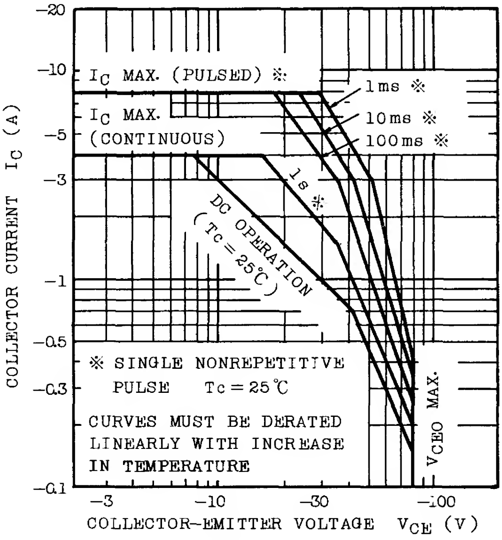
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA

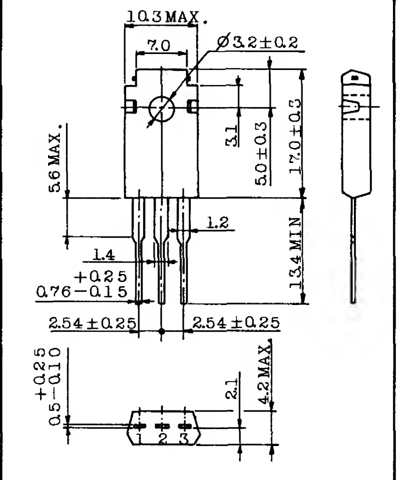


2SB997
2SB998
2SB999

SILICON PNP TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−10K1A

Weight : 2.0g

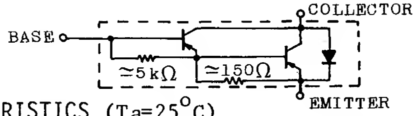
FEATURES:

- High DC Current Gain : $h_{FE}=2000$(Min.)(at $V_{CE}=-3\text{V}$, $I_C=-3\text{A}$)
- Low Saturation Voltage : $V_{CE(sat)}=-1.5\text{V}$(Max.)(at $I_C=-3\text{A}$)
- Complementary to 2SD1357, 2SD1358 and 2SD1359

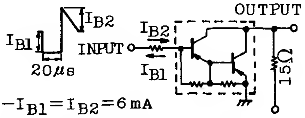
MAXIMUM RATINGS ($Ta=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SB997	V_{CBO}	-100	V
	2SB998		-80	
	2SB999		-60	
Collector-Emitter Voltage	2SB997	V_{CEO}	-100	V
	2SB998		-80	
	2SB999		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-0.2	A
Collector Power Dissipation ($Tc=25^\circ C$)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~150	°C

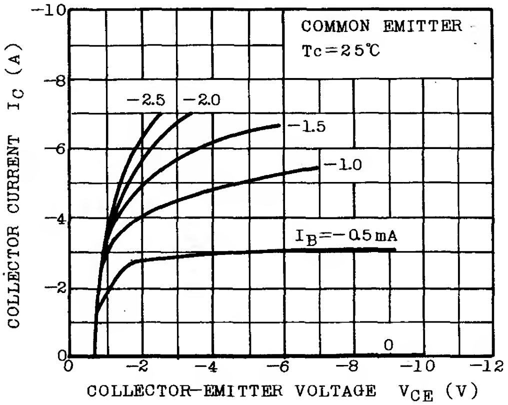
EQUIVALENT CIRCUIT



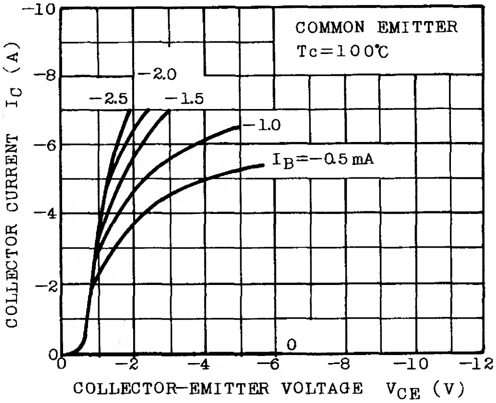
ELECTRICAL CHARACTERISTICS ($Ta=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SB997	I_{CBO}	$V_{CB}=-100\text{V}$, $I_E=0$	-	-	-100	µA
	2SB998		$V_{CB}=-80\text{V}$, $I_E=0$	-	-	-100	
	2SB999		$V_{CB}=-60\text{V}$, $I_E=0$	-	-	-100	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5\text{V}$, $I_C=0$	-	-	-4.0	mA
Collector-Emitter Breakdown Voltage	2SB997	$V_{(BR)CEO}$	$I_C=-50\text{mA}$, $I_B=0$	-100	-	-	V
	2SB998			-80	-	-	
	2SB999			-60	-	-	
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-3\text{V}$, $I_C=-3\text{A}$	2000	-	15000	
		$h_{FE(2)}$	$V_{CE}=-3\text{V}$, $I_C=-7\text{A}$	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	$I_C=-3\text{A}$, $I_B=-6\text{mA}$	-	-0.95	-1.5	V
		$V_{CE(sat)(2)}$	$I_C=-7\text{A}$, $I_B=-14\text{mA}$	-	-1.3	-2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-3\text{A}$, $I_B=-6\text{mA}$	-	-1.55	-2.5	V
Switching Time	Turn-on Time	t_{on}	 $-I_{B1}=I_{B2}=6\text{mA}$ DUTY CYCLE≦1% $V_{CC}=-45\text{V}$	-	0.8	-	µs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	2.5	-	

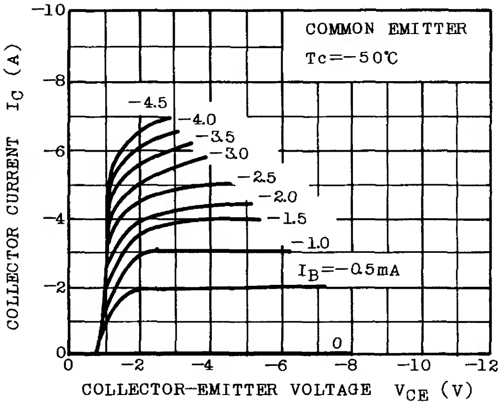
$I_C - V_{CE}$



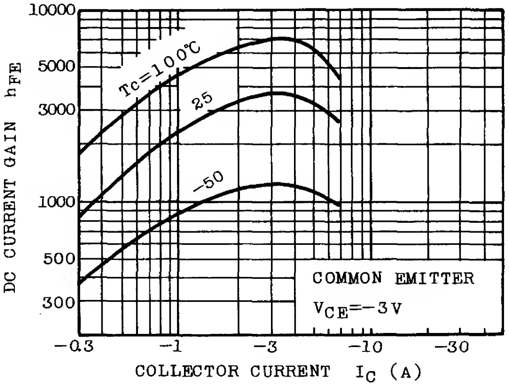
$I_C - V_{CE}$



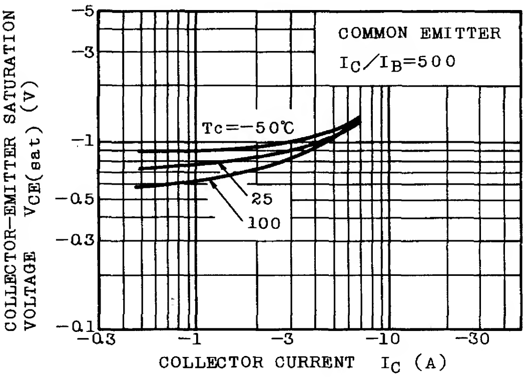
$I_C - V_{CE}$



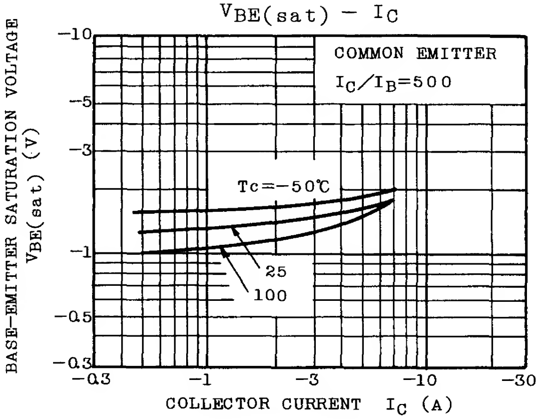
$h_{FE} - I_C$

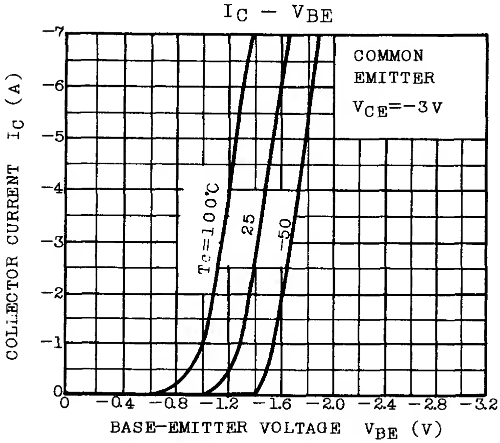


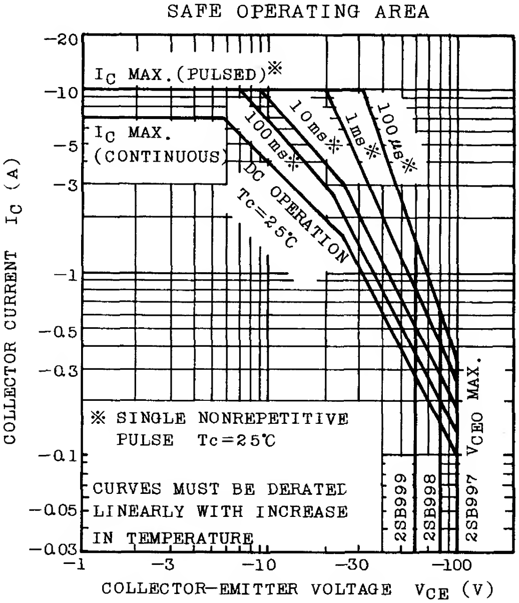
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$




IC − VBE
COMMON EMITTER
VCE=−3V
Tc=100℃
25
−50
COLLECTOR CURRENT IC (A)
−7
−6
−5
−4
−3
−2
−1
0
0
−0.4
−0.8
−1.2
−1.6
−2.0
−2.4
−2.8
−3.2
BASE−EMITTER VOLTAGE VBE (V)


SAFE OPERATING AREA
IC MAX.(PULSED)※
IC MAX.
(CONTINUOUS)
100ms※
10ms※
1ms※
100μs※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX.
2SB999
2SB998
2SB997
COLLECTOR CURRENT IC (A)
−20
−10
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−1
−3
−10
−30
−100
COLLECTOR−EMITTER VOLTAGE VCE (V)

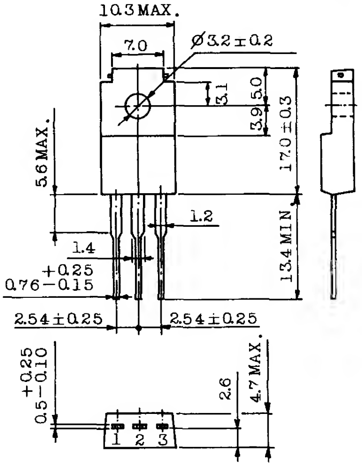
SILICON PNP TRIPLE DIFFUSED TYPE

2SB1015

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:
- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-1.0V$(Max.) at $I_C=-3A$, $I_B=-0.3A$
- Collector Power Dissipation : $P_C=25W$ ($T_c=25^\circ C$)
- Complementary to 2SD1406

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

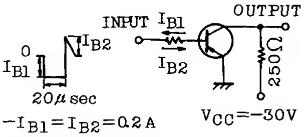
JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS ($T_a=25^\circ C$)

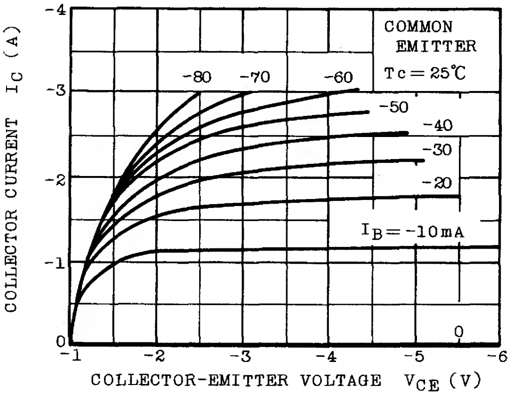
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

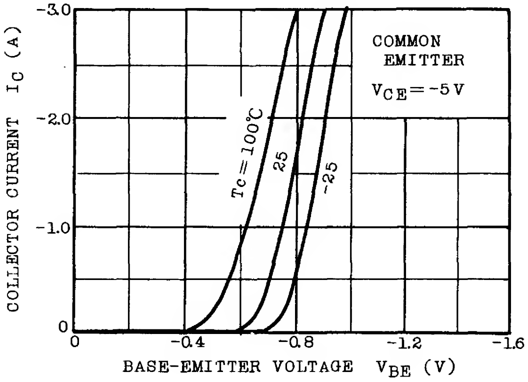
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-60V$, $I_E=0$	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-7V$, $I_C=0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA$, $I_B=0$	-60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-5V$, $I_C=-0.5A$	60	-	200	
		$h_{FE(2)}$	$V_{CE}=-5V$, $I_C=-3A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-3A$, $I_B=-0.3A$	-	-0.5	-1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=-5A$, $I_C=-0.5A$	-	-0.7	-1.0	V
Transition Frequency		f_T	$V_{CE}=-5V$, $I_C=-0.5A$	-	9	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B1} OUTPUT 0 I_{B2} I_{B1} I_{B2} 20μsec 250Ω $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.2A$ DUTY CYCLE≦1%	-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 60~120, Y : 100~200

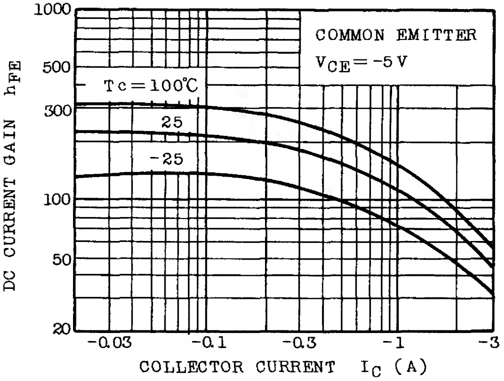
$I_C - V_{CE}$



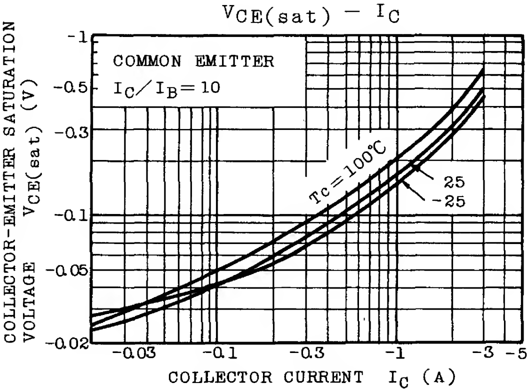
$I_C - V_{BE}$



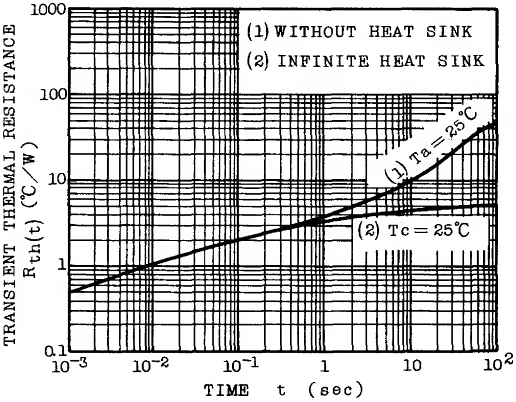
$h_{FE} - I_C$



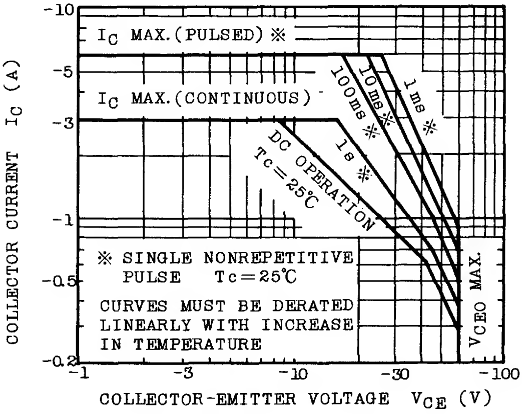
$V_{CE(sat)} - I_C$



$R_{th}(t) - t$



SAFE OPERATING AREA

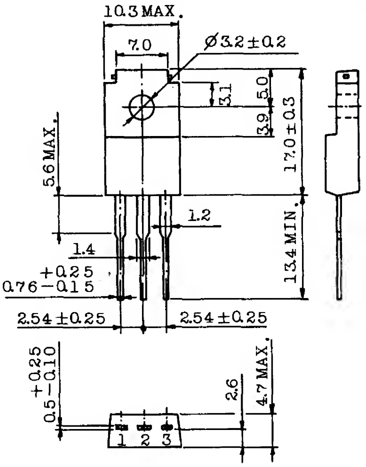


SILICON PNP TRIPLE DIFFUSED TYPE

2SB1016

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−10L1A

Weight : 2.1g

FEATURES:

- High Breakdown Voltage : V_{CEO}=-100V
- Low Collector-Emitter Saturation Voltage
  : $V_{CE(sat)}$=-2.0V(Max.)
- Complementary to 2SD1407
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

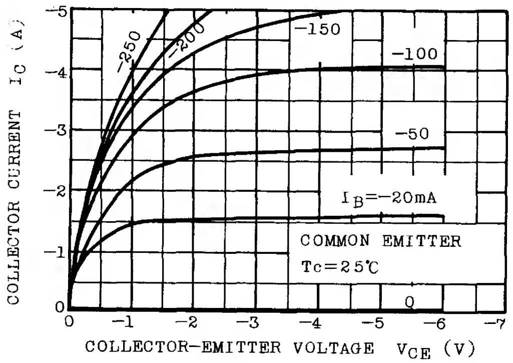
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

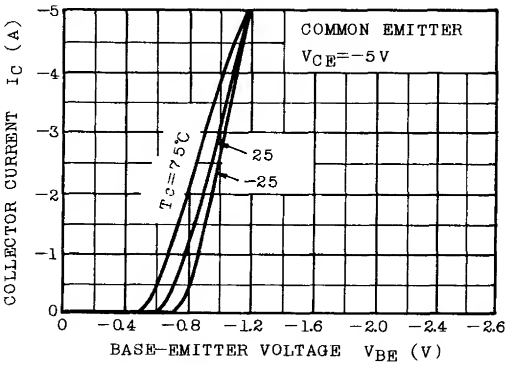
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-4A, I_B=0.4A	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-4A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-1A	-	5	-	MHz
Collector Output Capacitance	C_{OB}	V_{CB}=-10V, I_E=0, f=1MHz	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

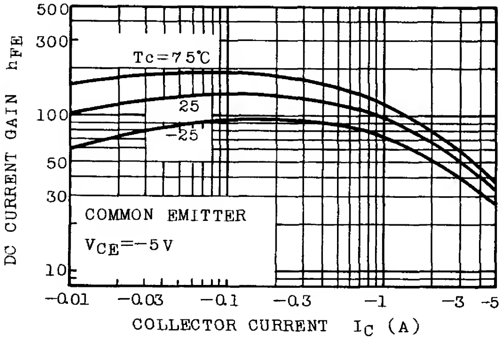
I_C – V_{CE}



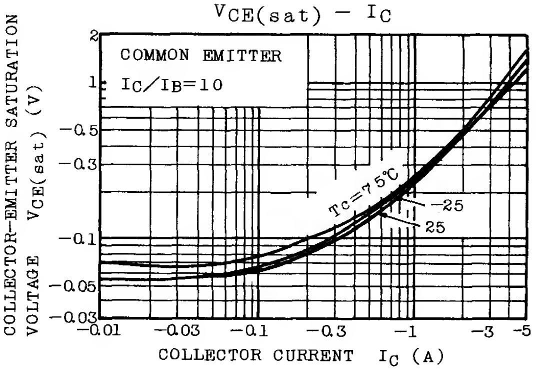
I_C – V_{BE}



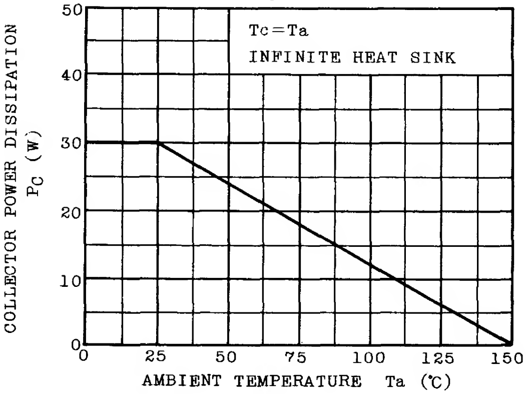
h_{FE} – I_C



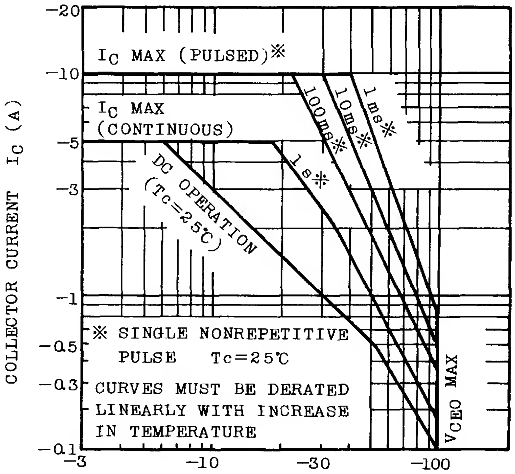
$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



SILICON PNP TRIPLE DIFFUSED TYPE

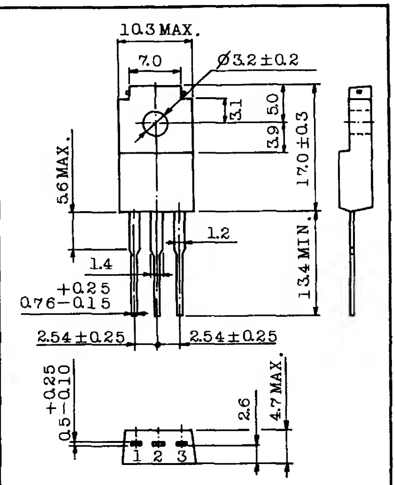
2SB1017

POWER AMPLIFIER APPLICATIONS.

Unit in mm

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SD1408
- Recommended for 20~25W High-Fiderity Audio Frequency Amplifier Output Stage.



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

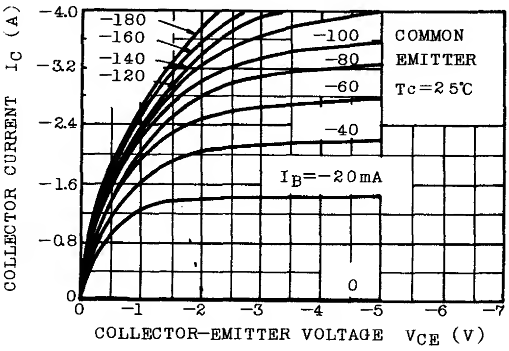
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-4	A
Base Current	I_B	-0.4	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

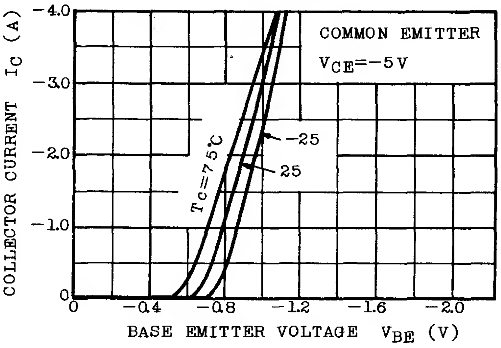
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-80V, I_E=0	-	-	-30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=-5V, I_C=-0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-3A	-	-1.0	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-0.5A	-	9	-	MHz
Collector Output Capacitance	Cob	V_{CB}=-10V, I_E=0, f=1MHz	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240

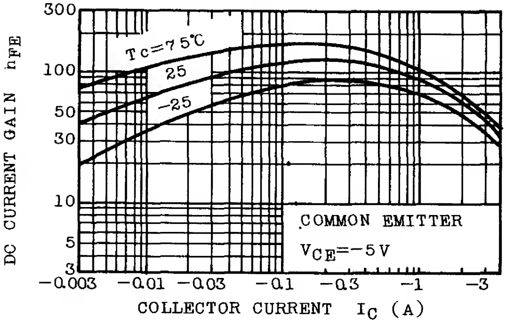
$I_C - V_{CE}$



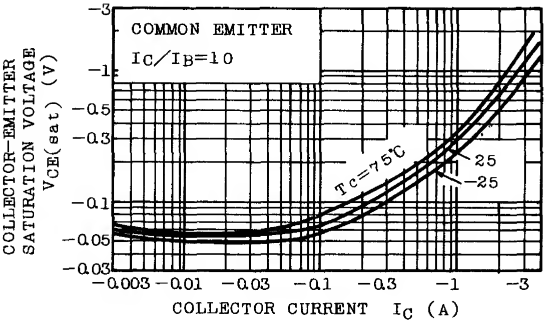
$I_C - V_{BE}$



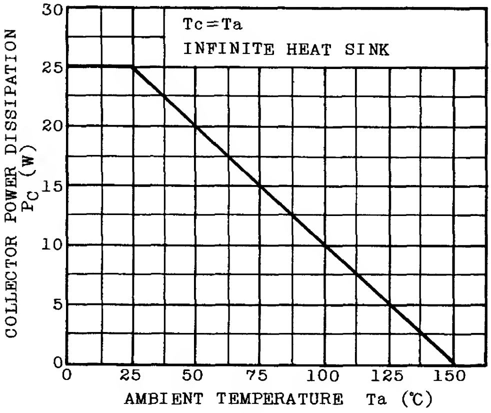
$h_{FE} - I_C$



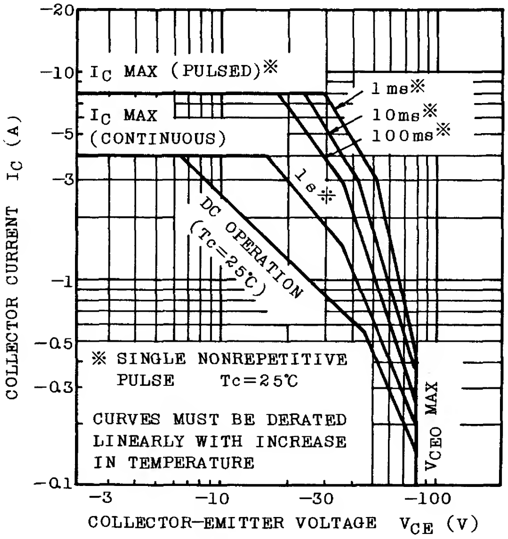
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



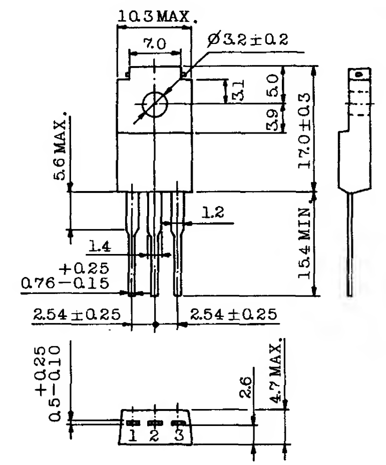
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

2SB1018

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:
- High Collector Current : I_C=-7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=-0.5V(Max.) at I_C=-4A
- Complementary to 2SD1411

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

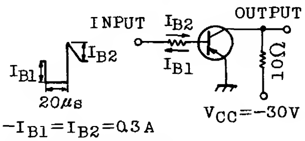
JEDEC	―
EIAJ	―
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

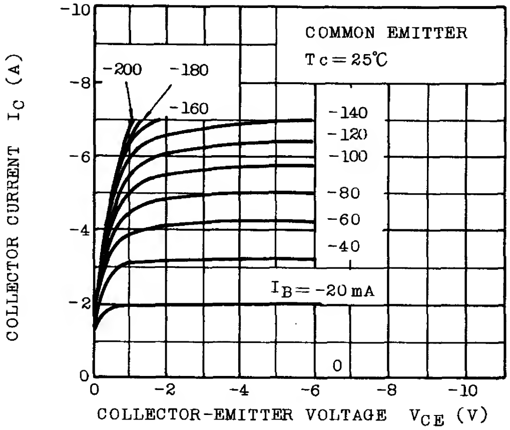
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

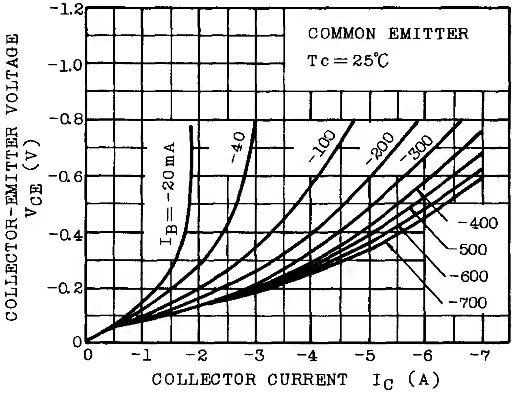
CHARACTERISTICS		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-100V, I_E=0	-	-	-5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=-1V, I_C=-1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=-1V, I_C=4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-0.9	-1.4	
Transition Frequency		f_T	V_{CE}=-4V, I_C=-1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B2} OUTPUT I_{B1} I_{B2} I_{B1} 20μs 10Ω V_{CC}=−30V $-I_{B1}=I_{B2}$=0.3 A DUTY CYCLE ≤1%	-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

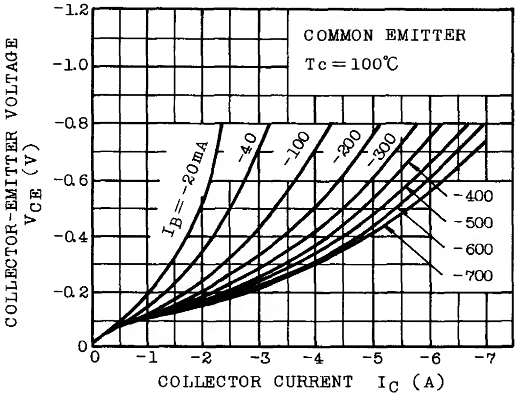
$I_C - V_{CE}$



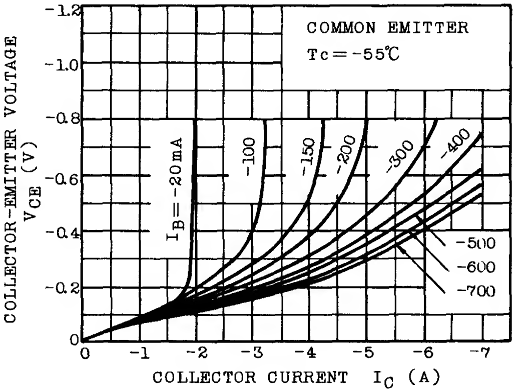
$V_{CE} - I_C$



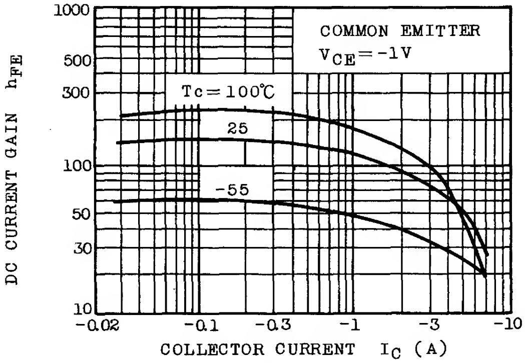
$V_{CE} - I_C$



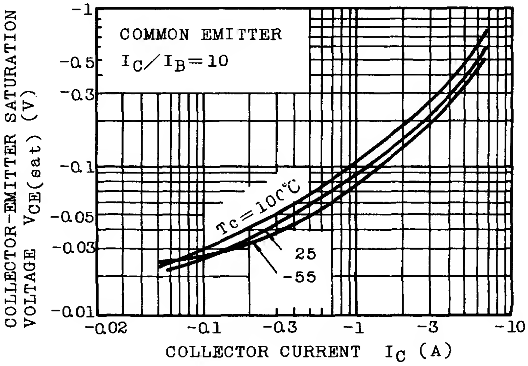
$V_{CE} - I_C$

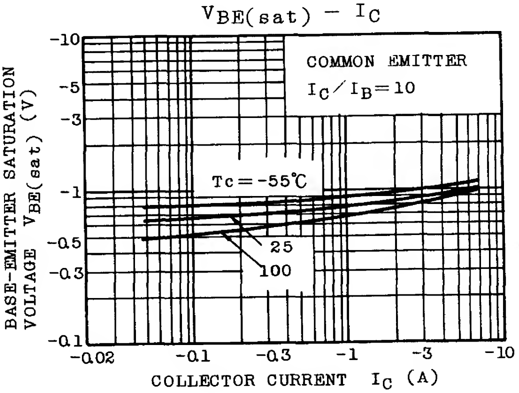


$h_{FE} - I_C$

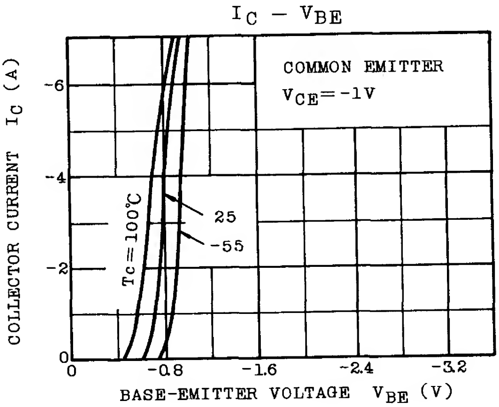


$V_{CE(sat)} - I_C$

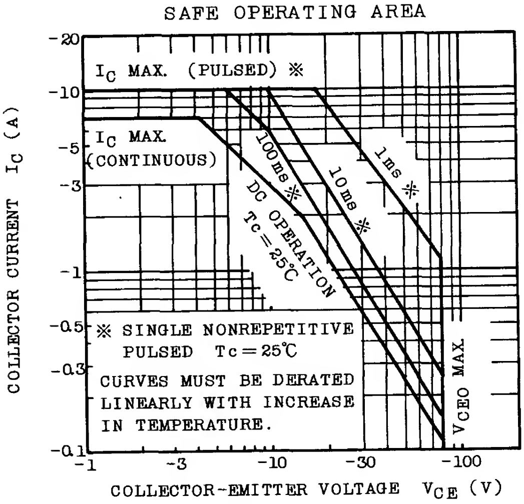




$V_{BE(sat)} - I_C$



$I_C - V_{BE}$



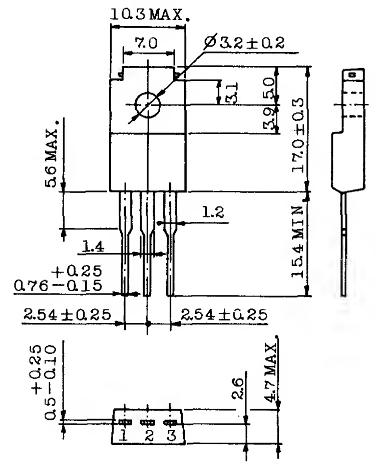
SAFE OPERATING AREA

2SB1019

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-10L1A

Weight : 2.1g

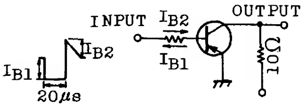
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=-0.4V$ (Max.) at $I_C=-4A$
- Complementary to 2SD1412

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

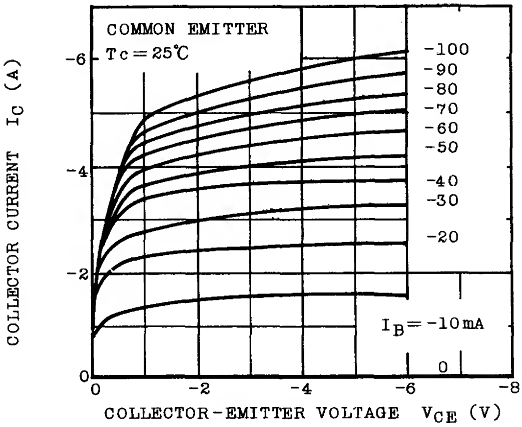
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-70	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	2.0	W
	$Tc=25^{\circ}C$		30	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55～150	$^{\circ}C$

ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

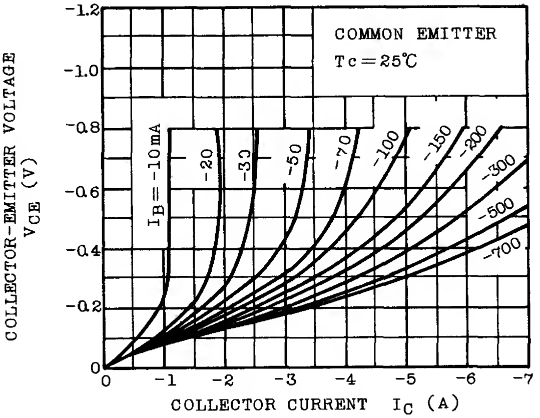
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-70V$, $I_E=0$	-	-	-30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-50mA$, $I_B=0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=-1V$, $I_C=-1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=-1V$, $I_C=-4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-4A$, $I_B=-0.4A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-4A$, $I_B=-0.4A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE}=-4V$, $I_C=-1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10V$, $I_E=0$, $f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B2} I_{B1} OUTPUT 10Ω I_{B1} I_{B2} 20μs $V_{CC}=-30V$ $-I_{B1}=I_{B2}=0.3A$ DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

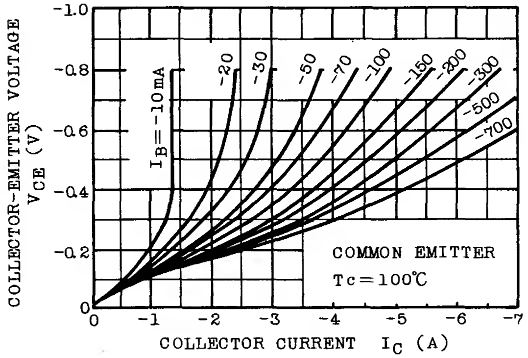
$I_C - V_{CE}$



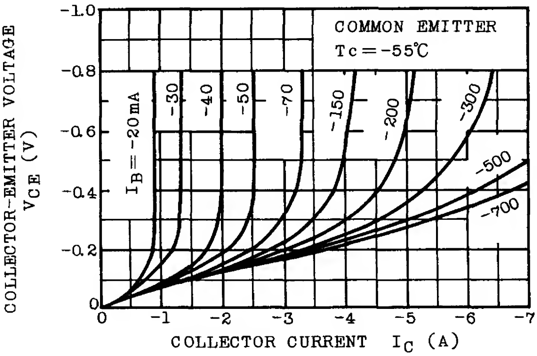
$V_{CE} - I_C$



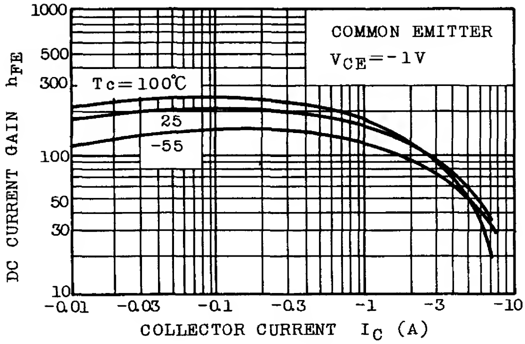
$V_{CE} - I_C$



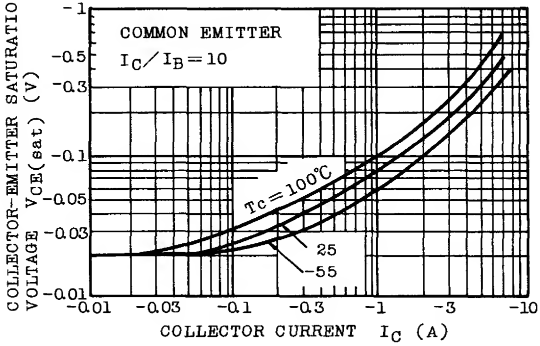
$V_{CE} - I_C$

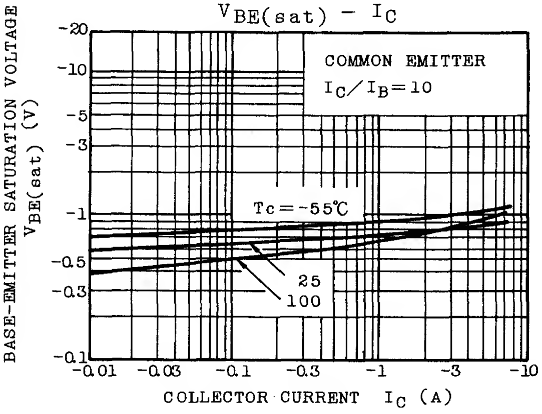


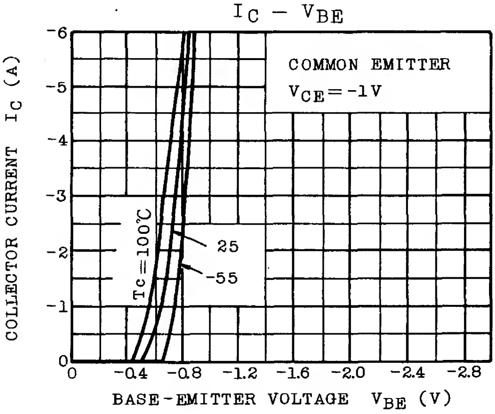
$h_{FE} - I_C$

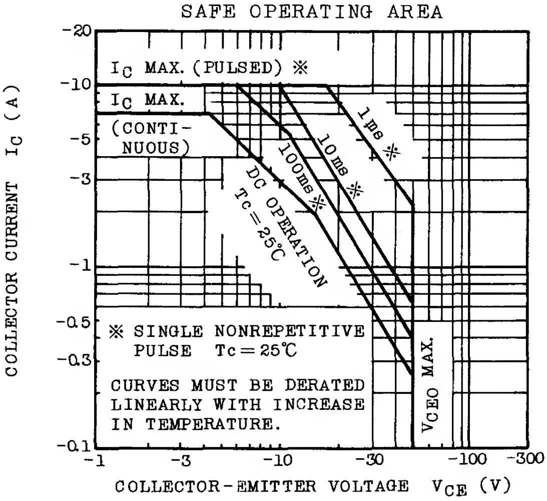


$V_{CE(sat)} - I_C$




VBE(sat) – IC
COMMON EMITTER
IC/IB=10
Tc=-55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
-20
-10
-5
-3
-1
-0.5
-0.3
-0.1
-0.01
-0.03
-0.1
-0.3
-1
-3
-10
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=-1V
Tc=100℃
25
-55
COLLECTOR CURRENT IC (A)
-6
-5
-4
-3
-2
-1
0
0
-0.4
-0.8
-1.2
-1.6
-2.0
-2.4
-2.8
BASE-EMITTER VOLTAGE VBE (V)

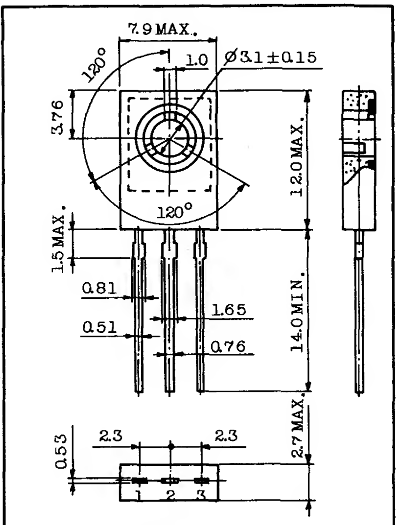

SAFE OPERATING AREA
IC MAX. (PULSED) ※
IC MAX.
(CONTINUOUS)
1ms※
10ms※
100ms※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.
COLLECTOR CURRENT IC (A)
-20
-10
-5
-3
-1
-0.5
-0.3
-0.1
-1
-3
-10
-30
-100
-300
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON PNP EPITAXIAL TYPE (DARLINGTON POWER)

2SB1034

MICRO MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Mounting Kit No. AC46C
Weight : 0.72g

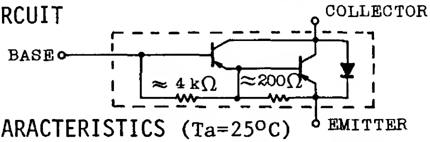
FEATURES:

- High DC Current Gain
  : h_{FE}=2000(Min.) (V_{CE}=-2V, I_C=-1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=-1.5V(Max.) (I_C=-1A, I_B=-1mA)

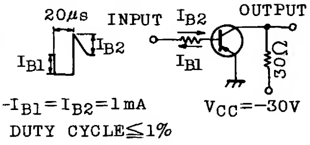
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-8	V
Collector Current	I_C	-2	A
Base Current	I_B	-0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

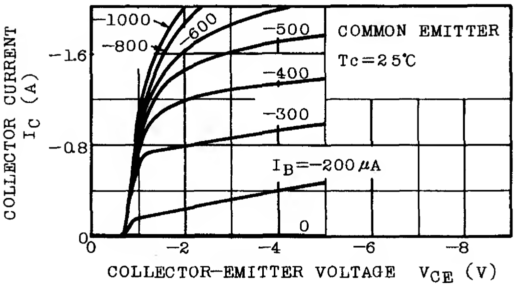
EQUIVALENT CIRCUIT



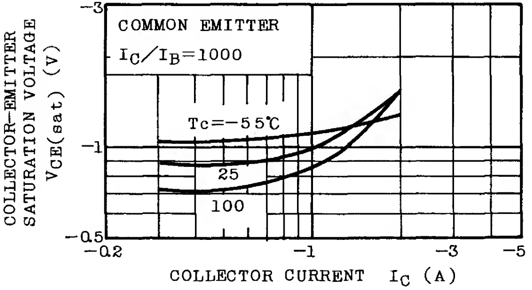
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-80V, I_E=0	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=-8V, I_C=0	-	-	-4	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-80	-	-	V
DC Current Gain		h_{FE}	V_{CE}=-2V, I_C=-1A	2000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-1A, I_B=-1mA	-	-	-1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=-1A, I_B=-1mA	-	-	-2.0	V
Transition Frequency		f_T	V_{CE}=-2V, I_C=-0.5A	-	50	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.4	-	

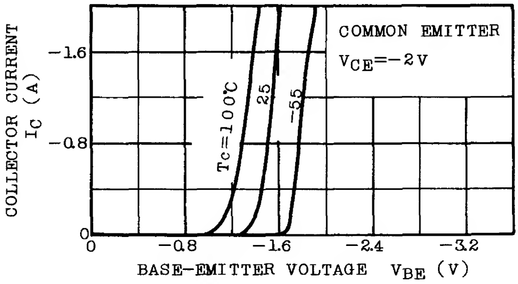
I_C – V_{CE}



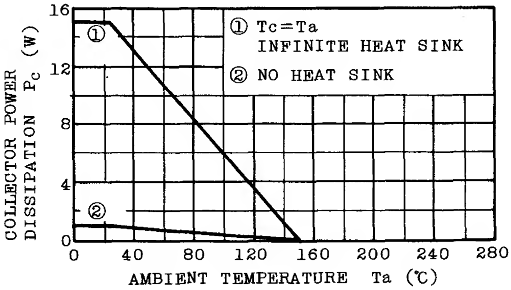
$V_{CE(sat)}$ – I_C



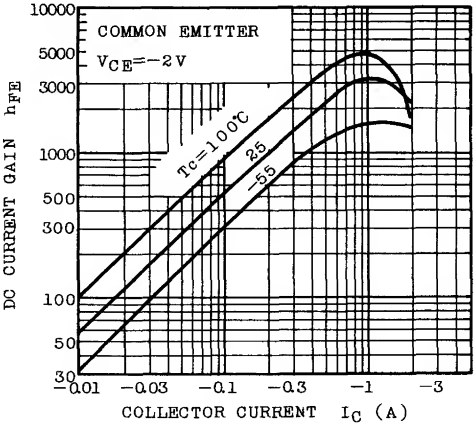
I_C – V_{BE}



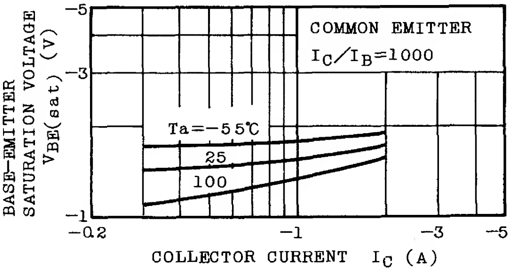
P_C – Ta



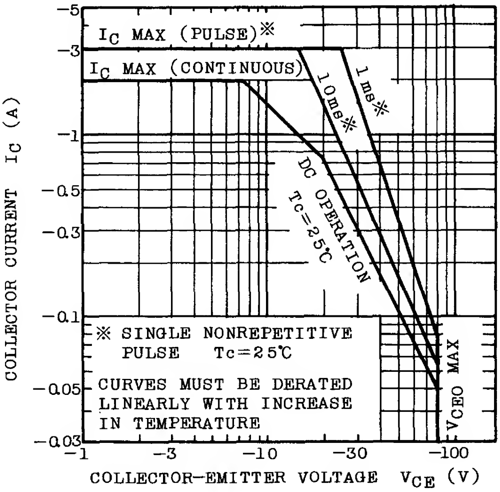
h_{FE} – I_C



$V_{BE(sat)}$ – I_C



SAFE OPERATING AREA



2SC
SERIES

2SC108A
2SC109A

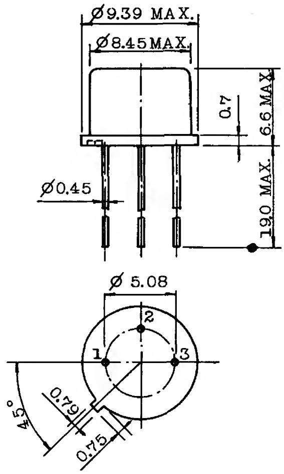
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Switching Speed: t_{stg}=60nS (Typ.)
- High Transition Frequency: f_T = 150MHz (Typ.)
- High Breakdown Voltage
  : V_{CBO}=90V (2SC108A)
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) at I_C=200mA, I_B=20mA

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

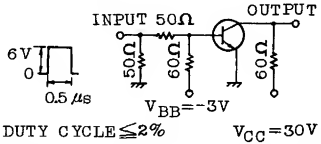
JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1A

Weight : 1.14g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC108A	V_{CBO}	90	v
	2SC109A		70	
Collector-Emitter Voltage	2SC108A	V_{CEO}	70	v
	2SC109A		50	
Emitter-Base Voltage		V_{EBO}	5	v
Collector Current		I_C	800	mA
Base Current		I_B	100	mA
Collector Power Dissipation		P_C	800	mW
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC108A	I_{CBO}	V_{CB}=80V, I_E=0	-	-	0.5	μA
	2SC109A		V_{CB}=60V, I_E=0				
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
DC Current Gain		h_{FE} (Note)	V_{CE}=2V, I_C=200mA	40	-	240	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=200mA, I_B=20mA	-	0.2	0.4	v
	Base-Emitter	$V_{BE(sat)}$	I_C=200mA, I_B=20mA	-	0.8	1.0	
Transition Frequency		f_T	V_{CE}=10V, I_C=10mA	100	150	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	9	15	pF
Switching Time	Turn-on Time	t_{on}			30	70	ns
	Storage Time	t_{stg}		-	60	80	
	Fall Time	t_f		-	20	40	

Note : h_{FE} Classification R : 40 ∿ 80, O : 70 ∿ 140, Y : 120 ∿ 240

2SC495
2SC496

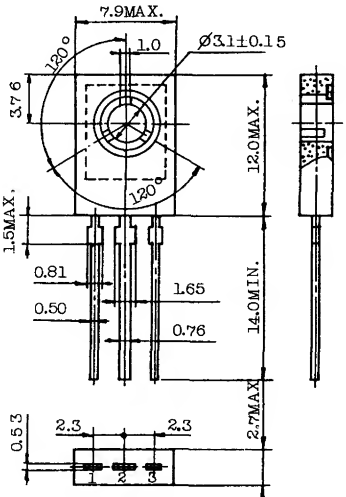
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.25V$ (Typ.)
- 0.5∿2 Watts Output Application.
- Complementary to 2SA505 and 2SA496.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO − 126
EIAJ	—
TOSHIBA	2 − 8F1A

Mounting Kit No. AC46C
Weight : 0.72g

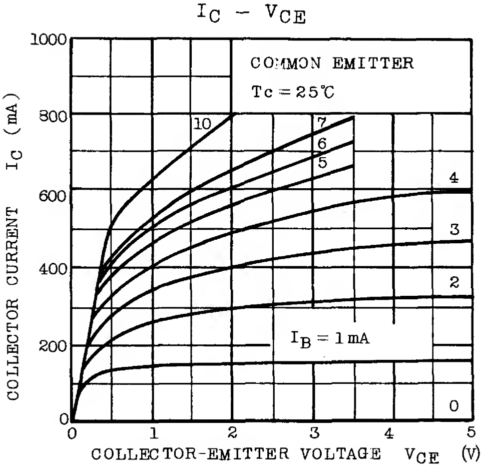
MAXIMUM RATINGS (Ta=25°C)

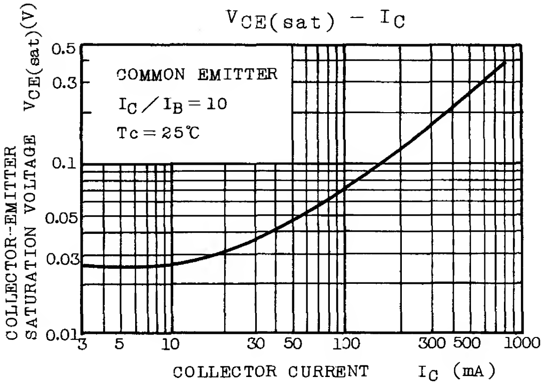
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC495	V_{CBO}	70	V
	2SC496		40	
Collector-Emitter Voltage	2SC495	V_{CEO}	50	V
	2SC496		30	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1	A
Emitter Current		I_E	-1	A
Collector Power Dissipation		P_C	1	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ∿ 150	°C

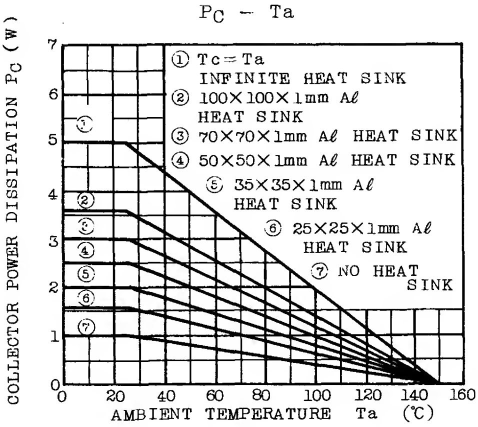
ELECTRICAL CHARACTERISTICS (Ta=25°C)

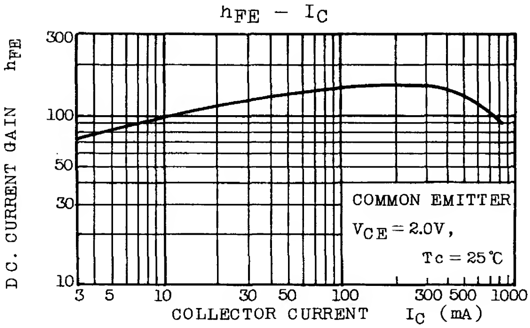
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V,\ I_E=0$	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V,\ I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	2SC495	$V_{(BR)CEO}$	$I_C=10mA,\ I_B=0$	50	-	-	V
	2SC496			30	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=1mA,\ I_C=0$	5	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=2V,\ I_C=50mA$	40	-	240	
		$h_{FE(2)}$	$V_{CE}=2V,\ I_C=800mA$	13	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=500mA,\ I_B=50mA$	-	0.25	0.8	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=2V,\ I_C=500mA$	-	0.9	1.1	V
Transition Frequency		f_T	$V_{CE}=10V,\ I_C=10mA$	50	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	10	-	pF

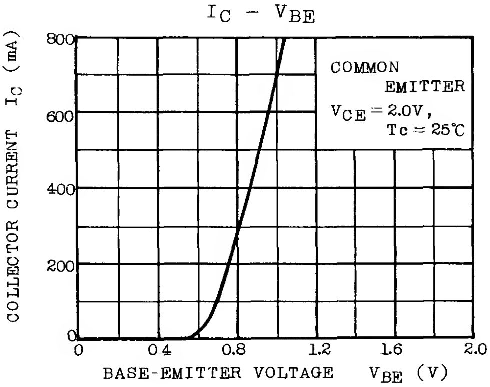
Note : $h_{FE(1)}$ Classification R : 40∿80, O : 70∿140, Y : 120∿240

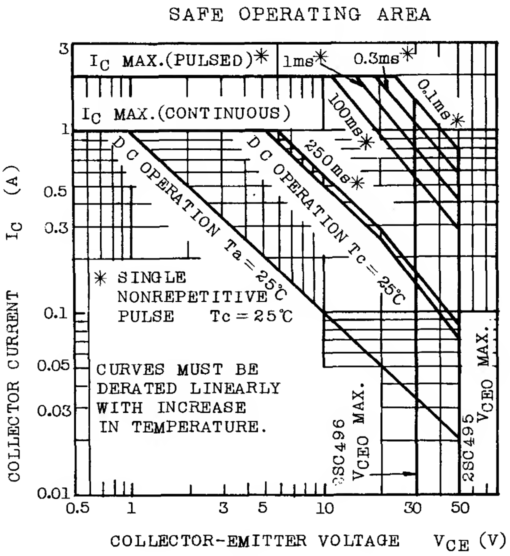

$I_C - V_{CE}$


$V_{CE(sat)} - I_C$


$P_C - T_a$


$h_{FE} - I_C$


$I_C - V_{BE}$


SAFE OPERATING AREA

2SC503
2SC504

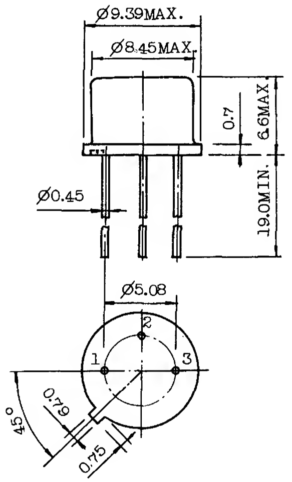
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=80MHz (Typ.)
- High Breakdown Voltage
  : V_{CEO}=80V (2SC503)
  : V_{CEO}=60V (2SC504)
- Complementary to 2SA503 and 2SA504.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

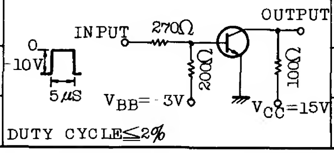
JEDEC	TO — 39	
EIAJ	TC — 5, TB — 5B	
TOSHIBA	2 — 8B1A	

Weight : 1.13g

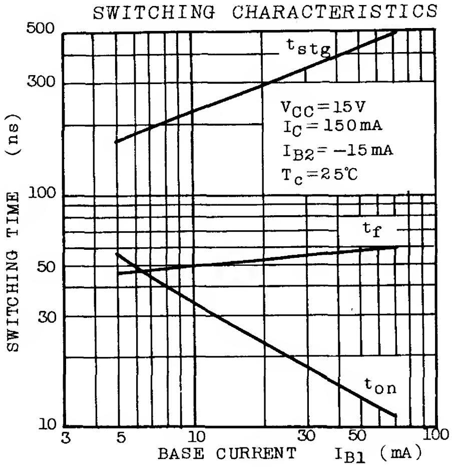
MAXIMUM RATINGS (Ta=25°C)

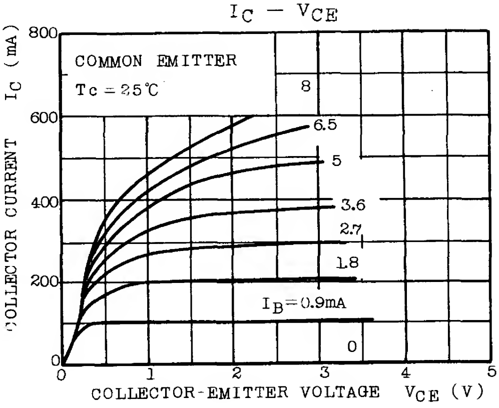
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC503	V_{CBO}	100	V
	2SC504		80	
Collector-Emitter Voltage	2SC503	V_{CEO}	80	V
	2SC504		60	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	600	mA
Base Current		I_B	100	mA
Collector Power Dissipation	Ta=25°C	P_C	800	mW
	Tc=25°C		6	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

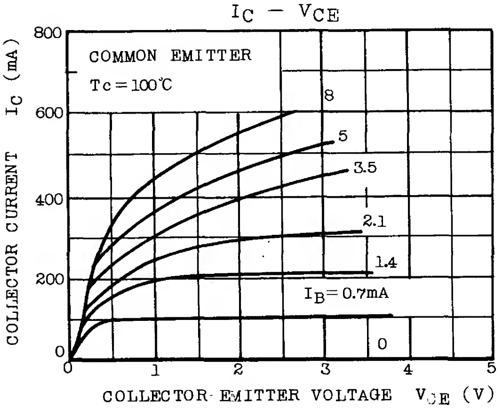
ELECTRICAL CHARACTERISTICS (Ta=25°C)

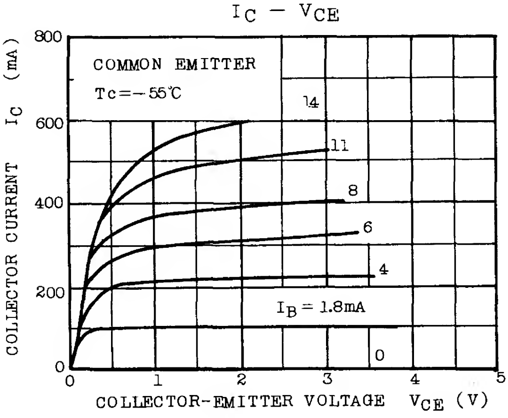
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC503	I_{CBO}	V_{CB}=80V, I_E=0	-	-	0.5	μA
	2SC504		V_{CB}=60V, I_E=0				
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
DC Current Gain		h_{FE} (Note)	V_{CE}=2V, I_C=150mA	30	-	300	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=150mA, I_B=15mA	-	0.06	0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=150mA, I_B=15mA	-	0.8	1.5	
Transition Frequency		f_T	V_{CE}=2V, I_C=150mA	50	80	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	13	30	pF
Base Intrinsic Resistance		$r_{bb'}$	V_{CE}=10V, I_E=-1mA, f=30MHz	-	16	25	Ω
Switching Time	Turn-on Time	t_{on}	 INPUT 270Ω OUTPUT 0 -10V 5μS 200Ω 100Ω V_{BB}=-3V V_{CC}=15V DUTY CYCLE≦2%	-	40	-	ns
	Storage Time	t_{stg}		-	450	-	
	Fall Time	t_f		-	100	-	

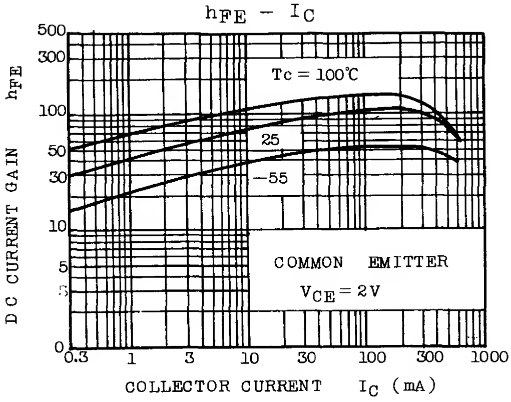
Note: h_{FE} Classification 0 : 30∿90, Y : 50∿150, GR : 100∿300

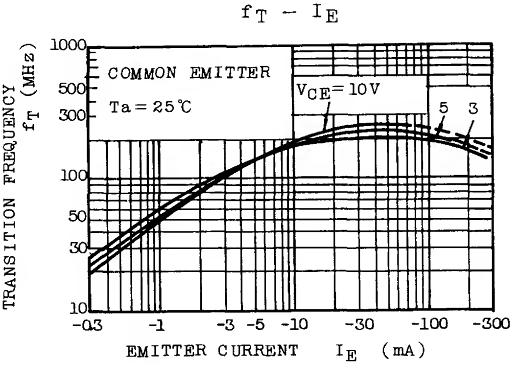

SWITCHING CHARACTERISTICS

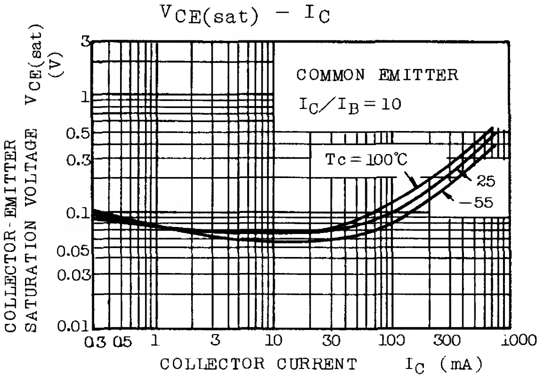

IC − VCE

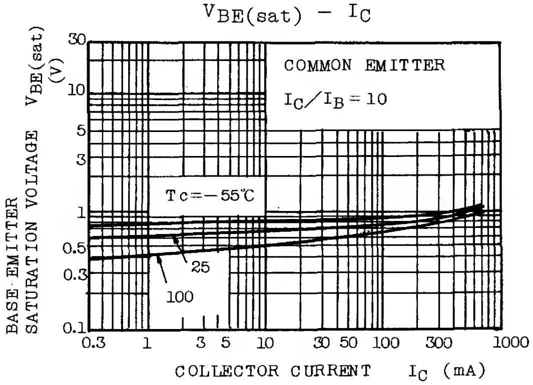

IC − VCE

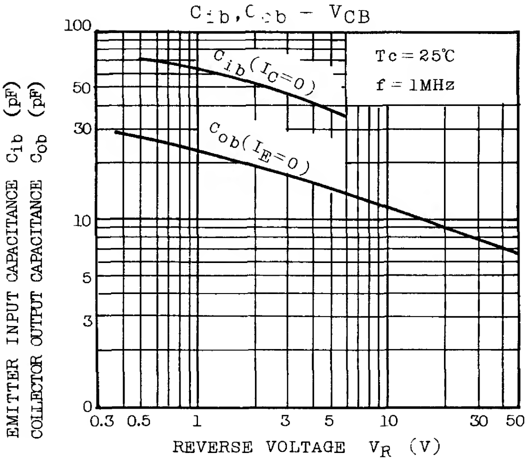

IC − VCE

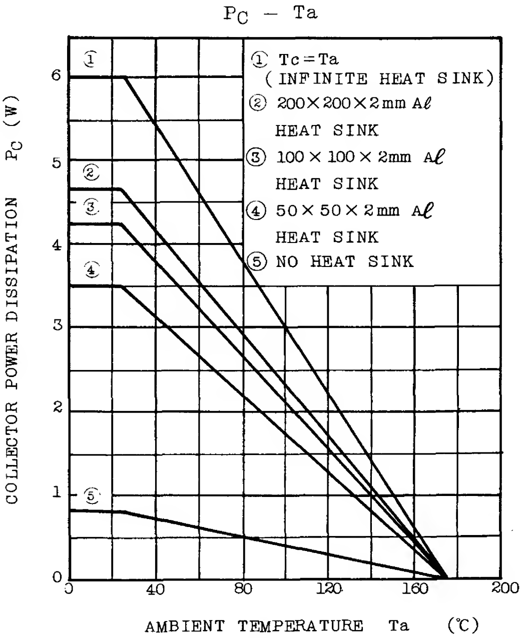

hFE − IC


fT − IE


VCE(sat) − IC
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
COMMON EMITTER
IC/IB = 10
Tc = 100℃
25
−55
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.3 0.5 1 3 10 30 100 300 1000
COLLECTOR CURRENT IC (mA)


VBE(sat) − IC
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
COMMON EMITTER
IC/IB = 10
Tc = −55℃
25
100
30
10
5
3
1
0.5
0.3
0.1
0.3 1 3 5 10 30 50 100 300 1000
COLLECTOR CURRENT IC (mA)


Cib, Cob − VCB
EMITTER INPUT CAPACITANCE Cib (pF)
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
Tc = 25℃
f = 1MHz
Cib(IC=0)
Cob(IE=0)
100
50
30
10
5
3
0
0.3 0.5 1 3 5 10 30 50
REVERSE VOLTAGE VR (V)


PC − Ta
COLLECTOR POWER DISSIPATION PC (W)
① Tc = Ta (INFINITE HEAT SINK)
② 200×200×2mm Aℓ HEAT SINK
③ 100×100×2mm Aℓ HEAT SINK
④ 50×50×2mm Aℓ HEAT SINK
⑤ NO HEAT SINK
①
②
③
④
⑤
6
5
4
3
2
1
0
0 40 80 120 160 200
AMBIENT TEMPERATURE Ta (℃)

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

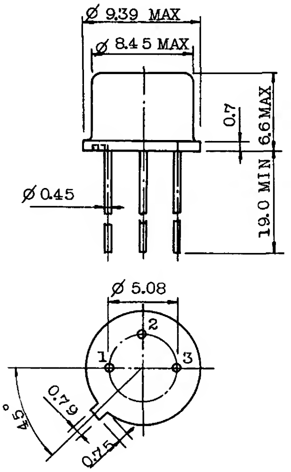
2SC505
2SC506

HIGH VOLTAGE AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=300V (2SC505)
  : V_{CEO}=200V (2SC506)

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1A

Weight : 1.14g

MAXIMUM RATINGS (Ta=25°C)

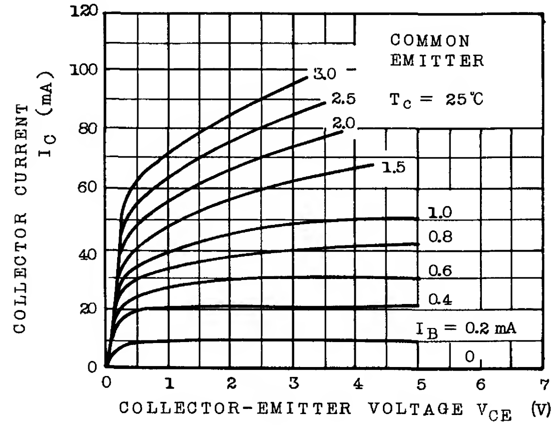
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC505	V_{CBO}	300	V
	2SC506		200	
Collector-Emitter Voltage	2SC505	V_{CEO}	300	V
	2SC506		200	
Emitter-Base Voltage		V_{EBO}	3	V
Collector Current		I_C	200	mA
Base Current		I_B	50	mA
Collector Power Dissipation		P_C	600	mW
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

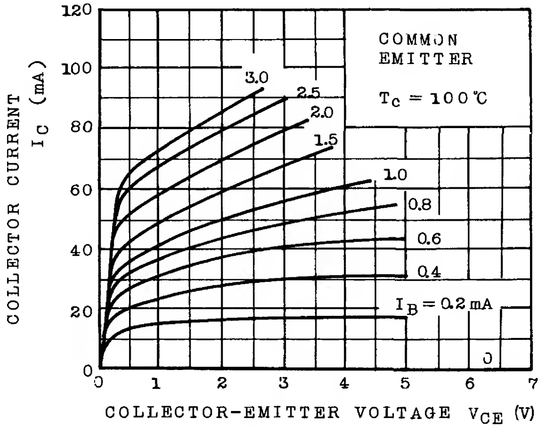
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=3V, I_C=0	-	-	1.0	μA
Collector-Base Breakdown Voltage	2SC505	$V_{(BR)CBO}$	I_C=0.1mA, I_E=0	300	-	-	V
	2SC506			200	-	-	
Collector-Emitter Breakdown Voltage	2SC505	$V_{(BR)CEO}$	I_C=2mA, I_B=0	300	-	-	V
	2SC506			200	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3	-	-	V
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=50mA	40	-	140	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=50mA, I_B=5mA	-	-	1.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=50mA, I_B=5mA	-	-	1.5	
Transition Frequency		f_T	V_{CE}=10V, I_C=10mA	30	60	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	20	pF
Base Intrinsic Resistance		$r_{bb'}$	V_{CE}=10V, I_E=-3mA, f=30MHz	-	-	20	Ω
Switching Time	Turn-on Time	t_{on}	V_{CC}=50V, I_C=10mA I_{B1}=$-I_{B2}$=1mA	-	0.3	-	μs
	Storage Time	t_{stg}		-	4	-	
	Fall Time	t_f		-	0.5	-	

Note: h_{FE} Classification R: 40∿80, O: 70∿140

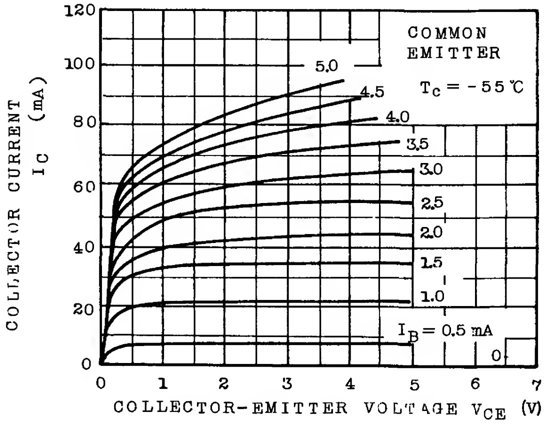
$I_C - V_{CE}$



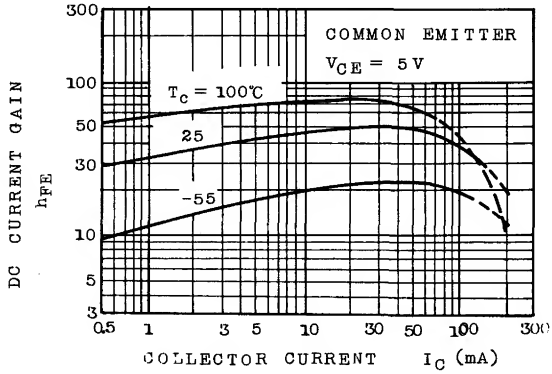
$I_C - V_{CE}$



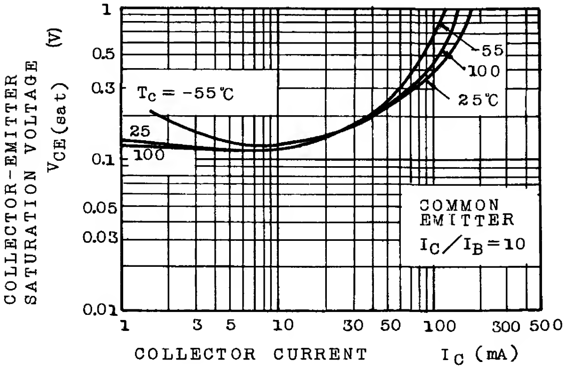
$I_C - V_{CE}$



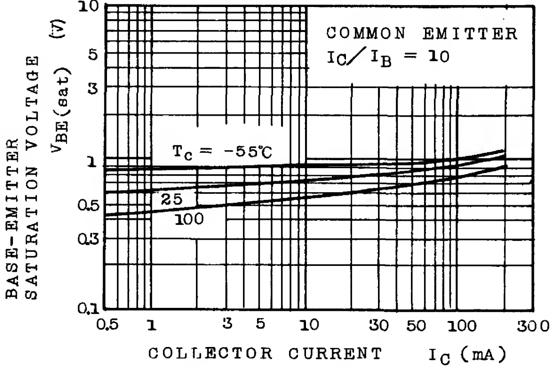
$h_{FE} - I_C$

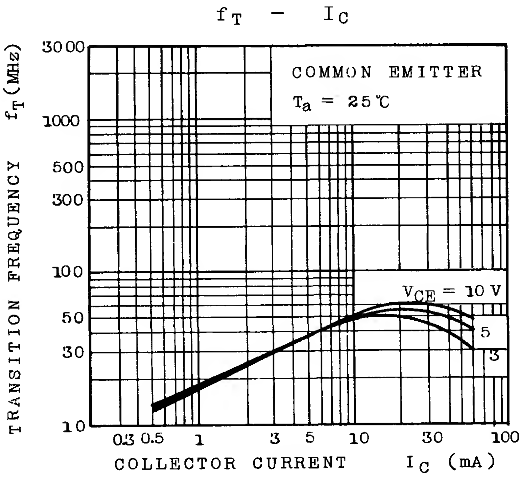


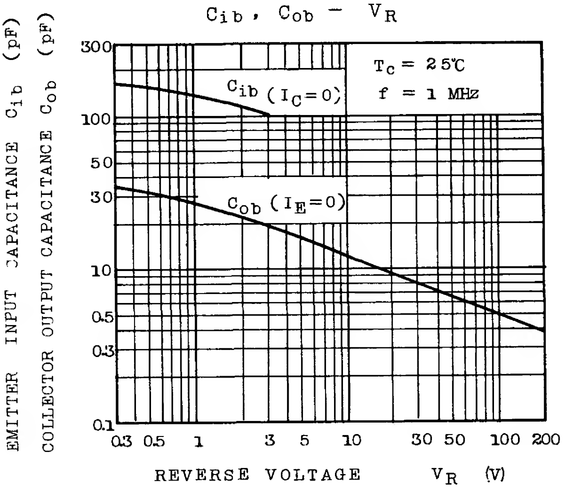
$V_{CE(sat)} - I_C$

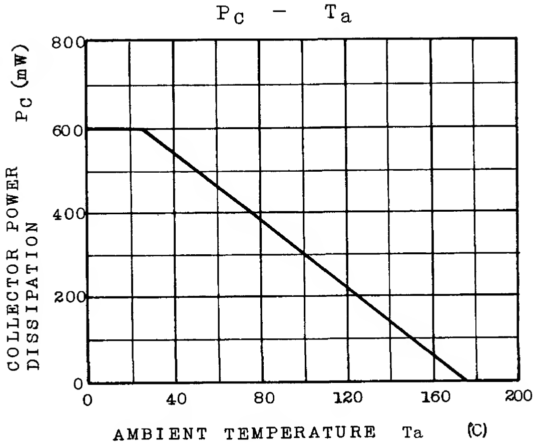


$V_{BE(sat)} - I_C$




f_T − I_C
COMMON EMITTER
T_a = 25℃
V_{CE} = 10 V
5
3
TRANSITION FREQUENCY f_T (MHz)
3000
1000
500
300
100
50
30
10
0.3 0.5 1 3 5 10 30 100
COLLECTOR CURRENT I_C (mA)


C_{ib}, C_{ob} − V_R
T_c = 25℃
f = 1 MHz
C_{ib} (I_C=0)
C_{ob} (I_E=0)
EMITTER INPUT CAPACITANCE C_{ib} (pF)
COLLECTOR OUTPUT CAPACITANCE C_{ob} (pF)
300
100
50
30
10
0.5
0.3
0.1
0.3 0.5 1 3 5 10 30 50 100 200
REVERSE VOLTAGE V_R (V)


P_C − T_a
COLLECTOR POWER DISSIPATION P_C (mW)
800
600
400
200
0
0 40 80 120 160 200
AMBIENT TEMPERATURE Ta (℃)

2SC507

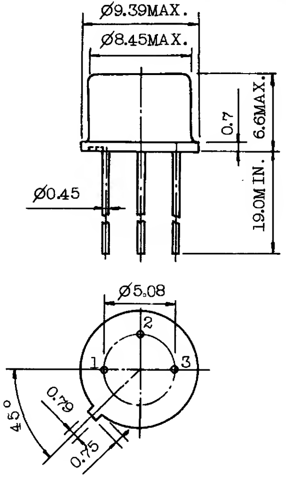
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

VIDEO AMPLIFIER APPLICATIONS.
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Breakdown Voltage
  : V_{CBO}=170V, V_{CEO}=120V
- High Gain and Excellent h_{FE} Linearity
  : I_C=100mA(Max.)
- High Transition Frequency : f_T=250MHz(Typ.)
- Low Output Capacitance : C_{ob}=2.8pF(Typ.)

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

JEDEC	TO — 39
EIAJ	TC — 5, TB — 5B
TOSHIBA	2 — 8B1A

Weight : 1.13g

MAXIMUM RATING (Ta=25°C)

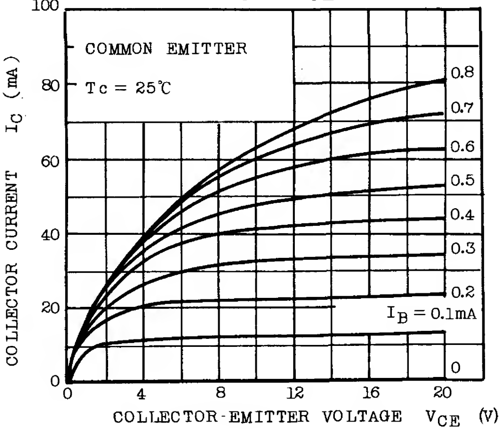
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	170	V
Collector-Emitter Voltage		V_{CEO}	120	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	100	mA
Base Current		I_B	20	mA
Collector Power Dissipation	Ta=25°C	P_C	750	mW
	Tc=25°C		23	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

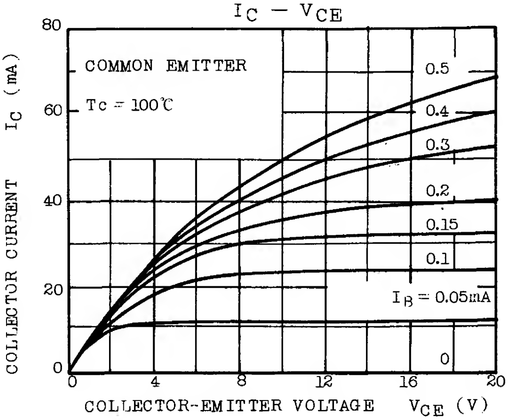
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V I_E=0	-	-	0.5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Breakdown Voltage	Collector-Base	$V_{(BR)CBO}$	I_C=0.1mA, I_E=0	170	-	-	V
	Collector-Emitter	$V_{(BR)CEO}$	I_C=1mA, I_B=0	120	-	-	
	Emitter-Base	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	5	-	-	
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=10mA	40	70	240	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=10mA, I_B=1mA	-	0.4	0.8	V
	Base-Emitter	$V_{BE(sat)}$	I_C=10mA, I_B=1mA	-	0.85	1.2	
Transition Frequency		f_T	V_{CE}=20V, I_C=10mA	100	250	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=20V, I_E=0, f=1MHz	-	2.8	4.0	pF

Note : h_{FE} Classification R : 40 ∿ 80, O : 70 ∿ 140, Y : 120 ∿ 240

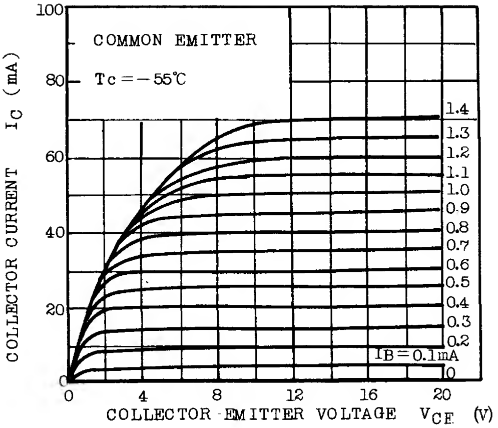
$I_C - V_{CE}$



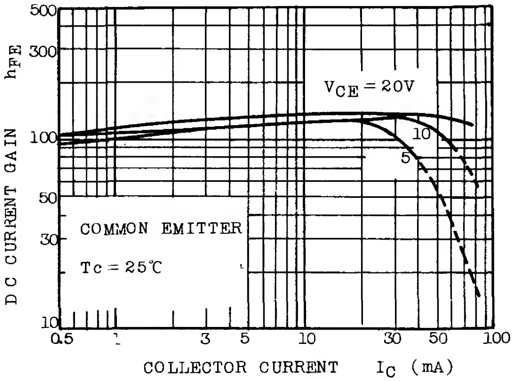
$I_C - V_{CE}$



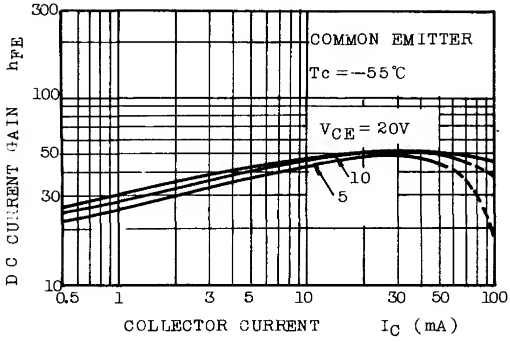
$I_C - V_{CE}$



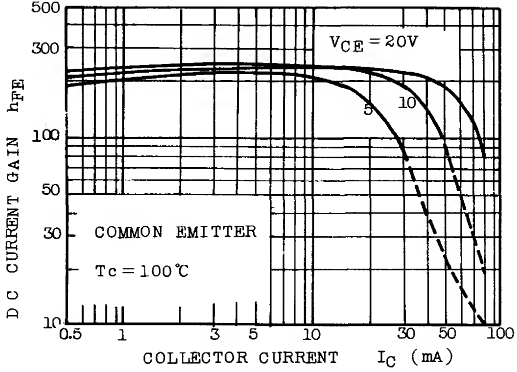
$h_{FE} - I_C$



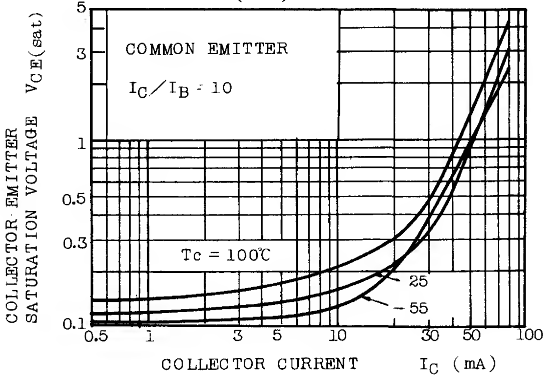
$h_{FE} - I_C$



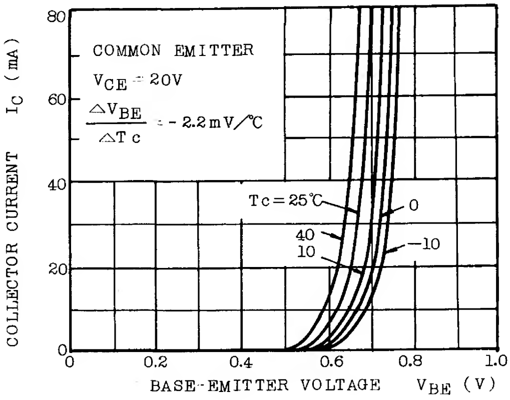
$h_{FE} - I_C$



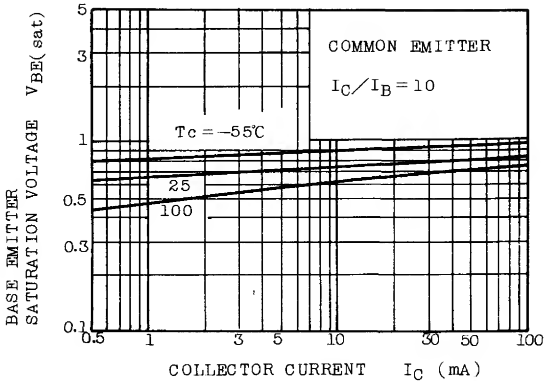
$V_{CE(sat)} - I_C$



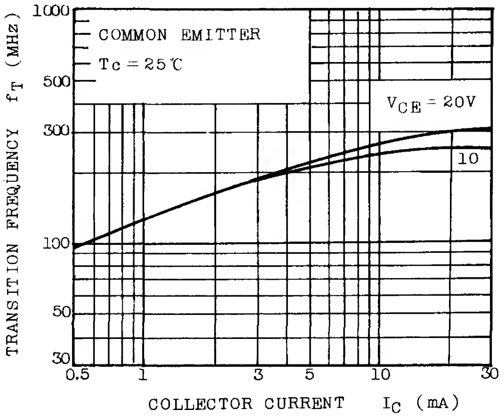
$I_C - V_{BE}$



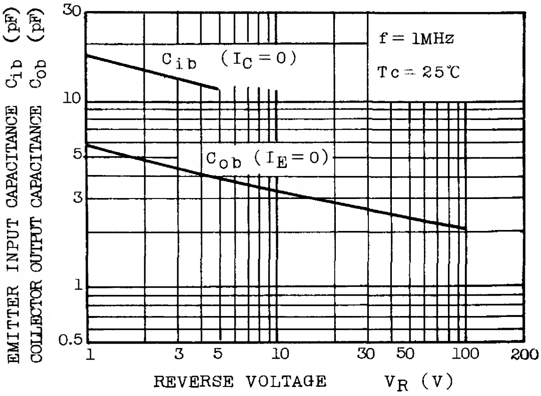
$V_{BE(sat)} - I_C$



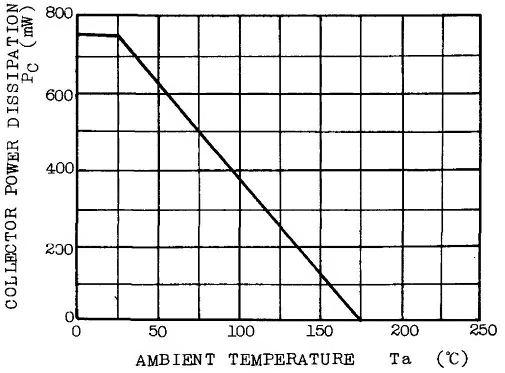
$f_T - I_C$



$C_{ib}, C_{ob} - V_R$



$P_C - Ta$



SILICON NPN TRIPLE DIFFUSED TYPE (PCT RPOCESS)

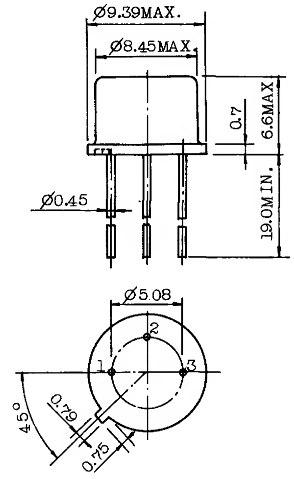
2SC510
2SC512

HIGH FREQUENCY POWER AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES :

- High Braekdown Voltage
  - : V_{CEO}=100V (2SC510)
  - : V_{CEO}= 60V (2SC512)
- Various Uses for Medium Power
  - : I_C(Max.) =1.5A
  - : P_C(Max.) =800mW(Ta=25°C), 8W(Tc=25°C)
- Complementary to 2SA510 and 2SA512.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

JEDEC	TO − 39
EIAJ	TC − 5, TB − 5B
TOSHIBA	2 − 8B1A

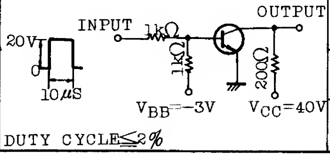
Weight : 1.13g

MAXIMUM RATINGS (Ta=25°C)

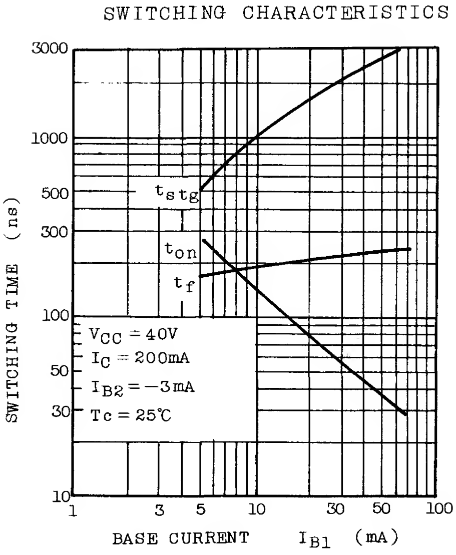
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC510	V_{CBO}	140	V
	2SC512		100	
Collector-Emitter Voltage	2SC510	V_{CEO}	100	V
	2SC512		60	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	300	mA
Collector Power Dissipation	Ta=25°C	P_C	800	mW
	Tc=25°C		8	W
Junction Temperatuer		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

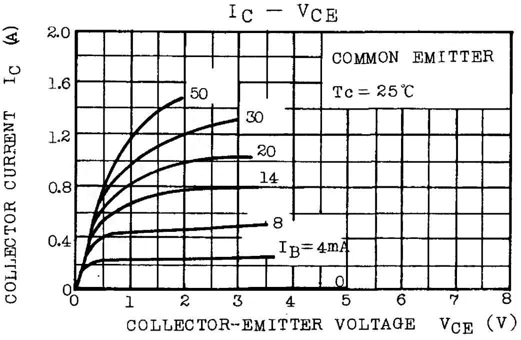
2SC510·2SC512

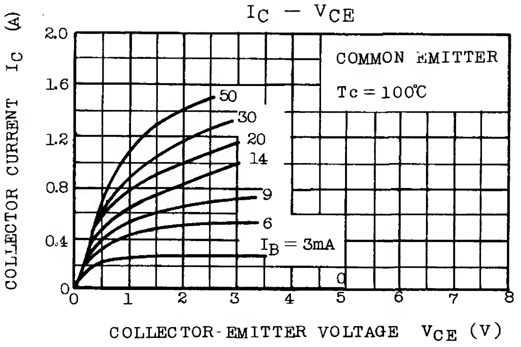
ELECTRICAL CHARACTERISTICS (Ta=25°C)

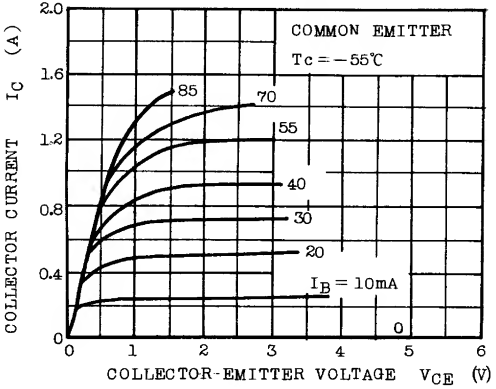
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5	μA
DC Current Gain		$h_{FE}(1)$ (Note)	V_{CE}=2V, I_C=200mA	30	-	150	
		$h_{FE}(2)$	V_{CE}=5V, I_C=1A	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=200mA, I_B=20mA	-	0.2	0.6	V
	Base-Emitter	$V_{BE(sat)}$	I_C=200mA, I_B=20mA	-	0.8	1.0	
Transition Frequency		f_T	V_{CE}=10V, I_C=30mA	20	60	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	25	40	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT 20V 0 10μS 1kΩ 1kΩ 200Ω V_{BB}=-3V V_{CC}=40V	-	0.13	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f	DUTY CYCLE≦2%	-	0.2	-	

Note : $h_{FE(1)}$ Classification R : 30∿90, O : 50∿150

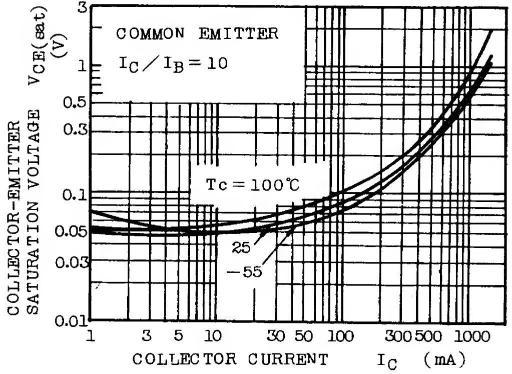

SWITCHING CHARACTERISTICS


I_C — V_{CE}

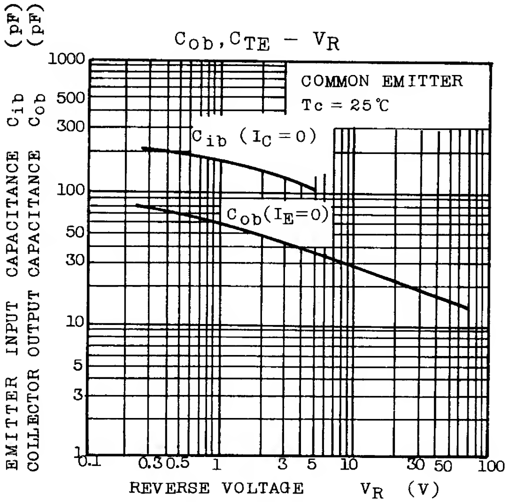

I_C — V_{CE}



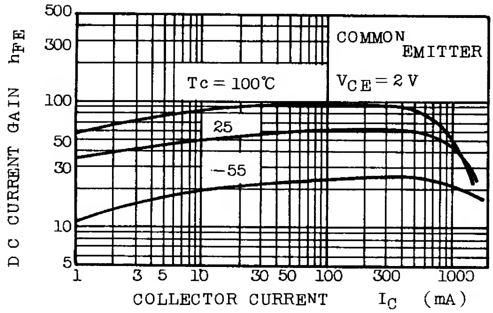
I_C – V_{CE}



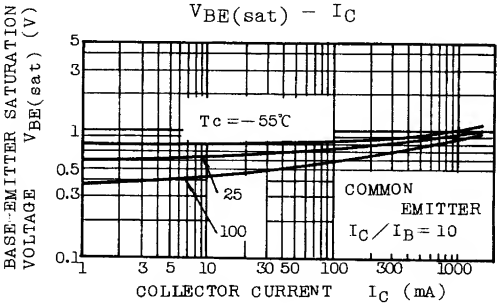
$V_{CE(sat)}$ – I_C



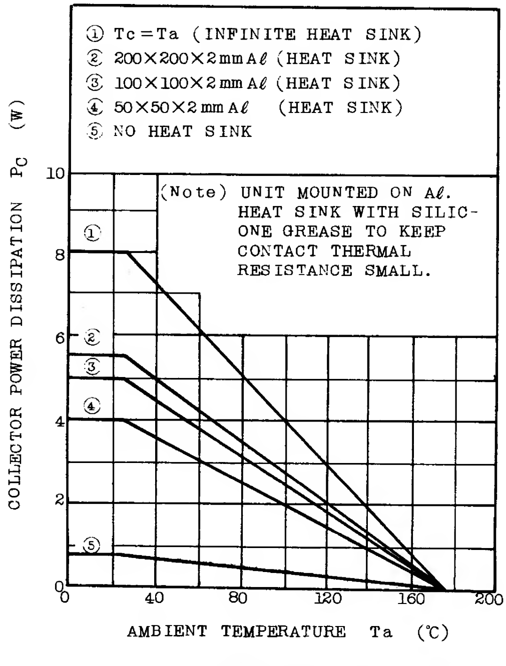
C_{ob}, C_{TE} – V_R



h_{FE} – I_C



$V_{BE(sat)}$ – I_C



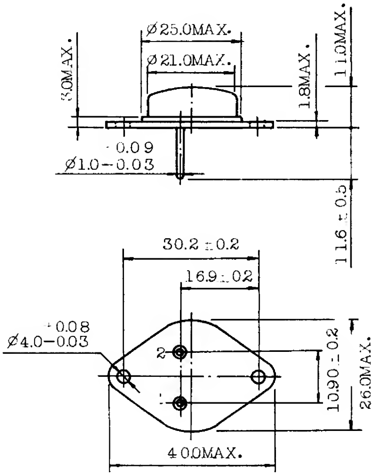
P_C – Ta

2SC519A
2SC520A
2SC521A

SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER, POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER, REGULATOR APPLICATIONS.

INDUSTRIAL APPLICATIONS
unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21A1A

Mounting Kit No. AC73
Weight : 12g

FEATURES:

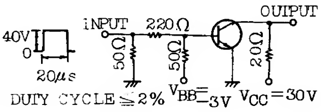
- High Voltage : V_{CBO}=130V(2SC519A),V_{CEO}=110V(2SC519A)
- High Collector Power Dissipation : P_C=50W (Tc=25°C)

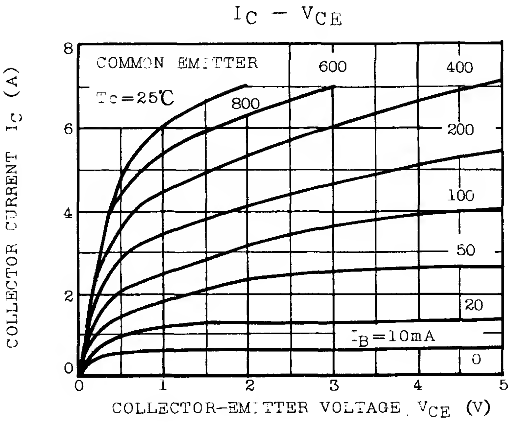
MAXIMUM RATINGS (Ta=25°C)

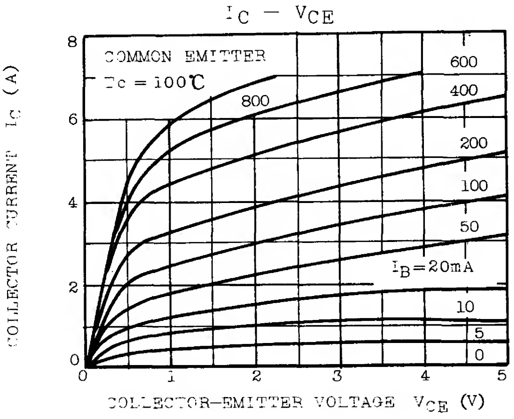
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC519A	V_{CBO}	130	V
	2SC520A		100	
	2SC521A		70	
Collector-Emitter Voltage	2SC519A	V_{CEO}	110	V
	2SC520A		80	
	2SC521A		50	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	2	A
Collector Power Dissipation	Tc=25°C	P_C	50	W
	(Note)		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−65∼150	°C

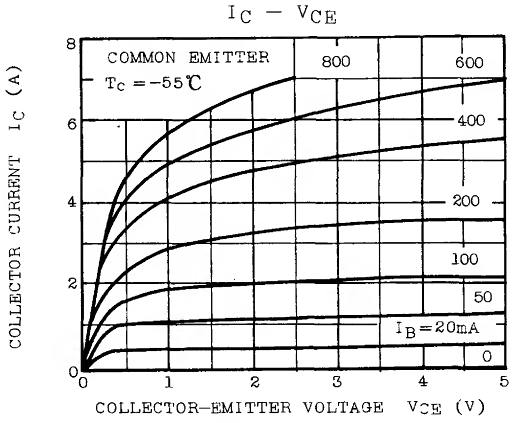
Note : Unit Mounted On a 300×300×2mmAℓ Heat Sink With Silicone Greased Mica Insulator

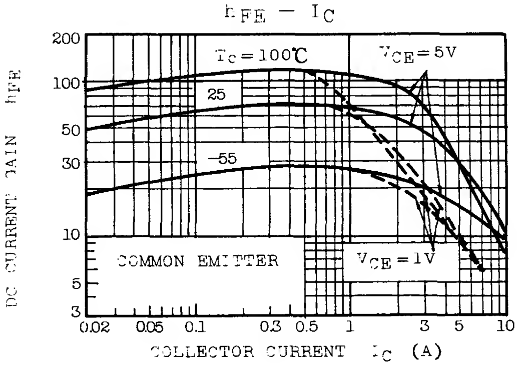
ELECTRICAL CHARACTERISTICS (Ta=25°C)

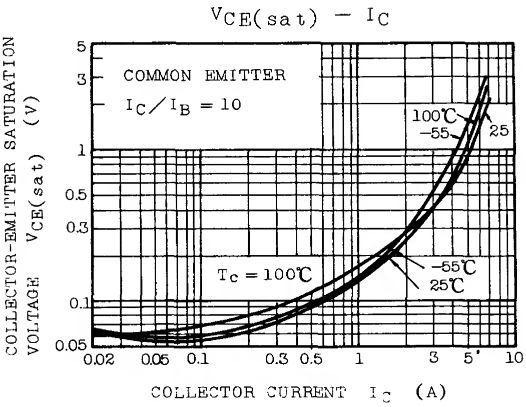
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC519A	I_{CBO}	V_{CB}=130V, I_E=0	−	−	100	μA
	2SC520A		V_{CB}=100V, I_E=0	−	−	100	
	2SC521A		V_{CB}=70V, I_E=0	−	−	100	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	5	mA
Collector-Emitter Breakdown Voltage	2SC519A	$V_{(BR)CEO}$	I_C=50mA, I_B=0	110	−	−	V
	2SC520A		I_C=50mA, I_B=0	80	−	−	
	2SC521A		I_C=50mA, I_B=0	50	−	−	
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=1A	30	−	300	
		$h_{FE(2)}$	V_{CE}=5V, I_C=5A	15	−	−	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=5A, I_B=1A	−	0.6	2.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=5A, I_B=1A	−	1.3	2.5	
Transition Frequency		f_T	V_{CE}=10V, I_C=1A	−	10	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=50V,I_E=0,f=1MHz	−	90	250	pF
Switching Time	Turn-on Time	t_{on}	 INPUT 220Ω OUTPUT 40V 0 20μs 50Ω 50Ω 20Ω DUTY CYCLE≦2% VBB=−3V VCC=30V	−	0.4	−	μs
	Storage Time	t_{stg}		−	4.5	−	
	Fall Time	t_f		−	0.4	−	

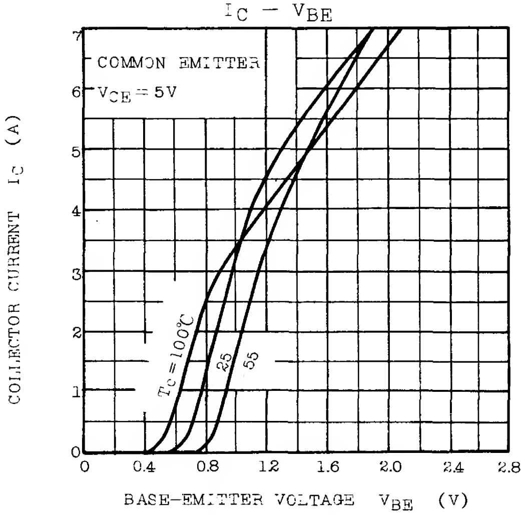

I_C — V_{CE}
COMMON EMITTER
Tc=25℃
800
600
400
200
100
50
20
I_B=10mA
0
COLLECTOR CURRENT I_C (A)
0
2
4
6
8
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

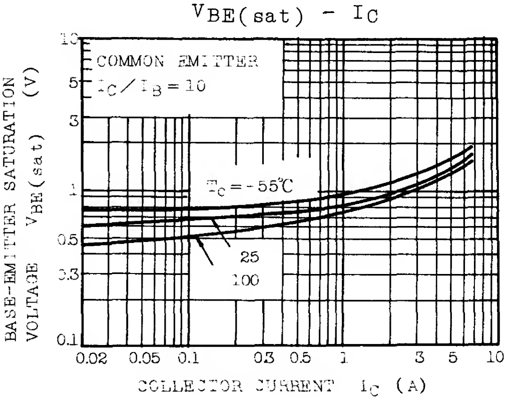

I_C — V_{CE}
COMMON EMITTER
Tc=100℃
800
600
400
200
100
50
I_B=20mA
10
5
0
COLLECTOR CURRENT I_C (A)
0
2
4
6
8
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

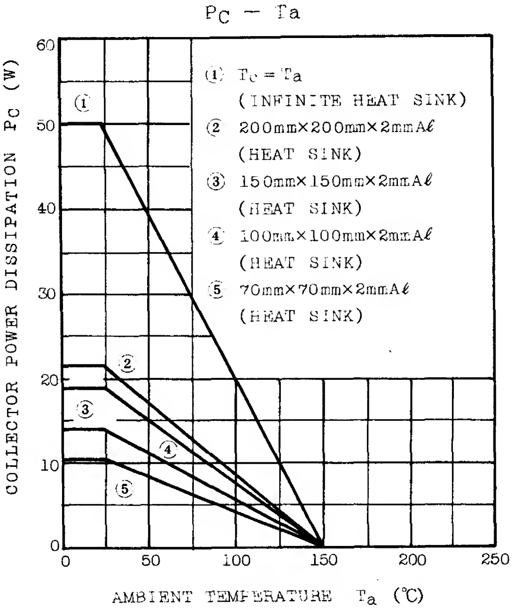

I_C — V_{CE}
COMMON EMITTER
Tc=−55℃
800
600
400
200
100
50
I_B=20mA
0
COLLECTOR CURRENT I_C (A)
0
2
4
6
8
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

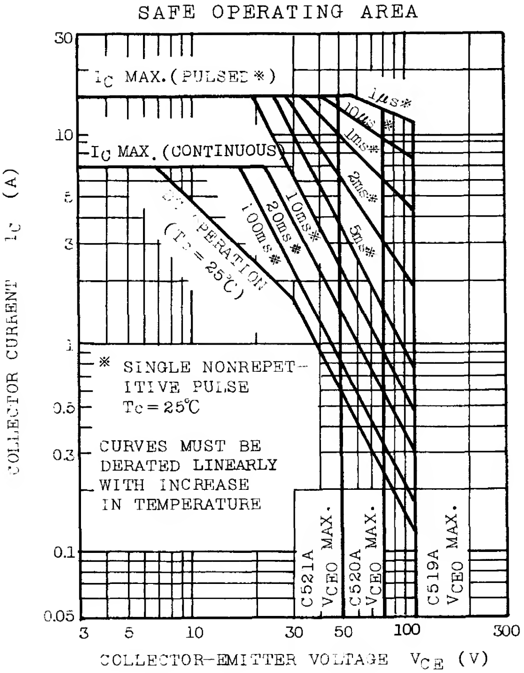

h_{FE} — I_C
Tc=100℃
V_{CE}=5V
25
−55
COMMON EMITTER
V_{CE}=1V
DC CURRENT GAIN h_{FE}
3
5
10
30
50
100
200
0.02
0.05
0.1
0.3
0.5
1
3
5
10
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)}$ — I_C
COMMON EMITTER
I_C/I_B = 10
100℃
−55
25
Tc=100℃
−55℃
25℃
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0.05
0.1
0.3
0.5
1
3
5
0.02
0.05
0.1
0.3
0.5
1
3
5
10
COLLECTOR CURRENT I_C (A)


I_C — V_{BE}
COMMON EMITTER
V_{CE}=5V
Tc=100℃
25
55
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
5
6
7
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
BASE-EMITTER VOLTAGE V_{BE} (V)


$V_{BE(sat)}$ – I_C
COMMON EMITTER
$I_C/I_B=10$
$T_c=-55$℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
10
5
3
1
0.5
0.3
0.1
0.02
0.05
0.1
0.3
0.5
1
3
5
10
COLLECTOR CURRENT I_C (A)


P_C – T_a
① $T_c=T_a$ (INFINITE HEAT SINK)
② 200mm×200mm×2mm Aℓ (HEAT SINK)
③ 150mm×150mm×2mm Aℓ (HEAT SINK)
④ 100mm×100mm×2mm Aℓ (HEAT SINK)
⑤ 70mm×70mm×2mm Aℓ (HEAT SINK)
COLLECTOR POWER DISSIPATION P_C (W)
60
50
40
30
20
10
0
0
50
100
150
200
250
AMBIENT TEMPERATURE T_a (℃)


SAFE OPERATING AREA
I_C MAX. (PULSED ※)
I_C MAX. (CONTINUOUS)
1µs※
10µs※
1ms※
2ms※
5ms※
10ms※
20ms※
100ms※
DC OPERATION ($T_c=25$℃)
※ SINGLE NONREPETITIVE PULSE $T_c=25$℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
C521A V_{CEO} MAX.
C520A V_{CEO} MAX.
C519A V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
3
5
10
30
50
100
300
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

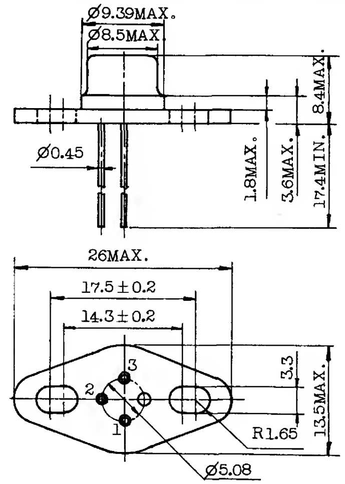
2SC522
2SC524

HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=100V (2SC522)
  : V_{CEO}= 60V (2SC524)
- Useful attachment for Heat sink.
- Various Uses for Medium Power
  : I_C=1.5A (Max.), P_C=10W (Max.)

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

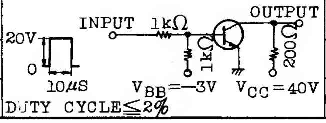
JEDEC	–
EIAJ	–
TOSHIBA	2 – 9A1A

Mounting kit No. AC26C
Weight : 3.7g

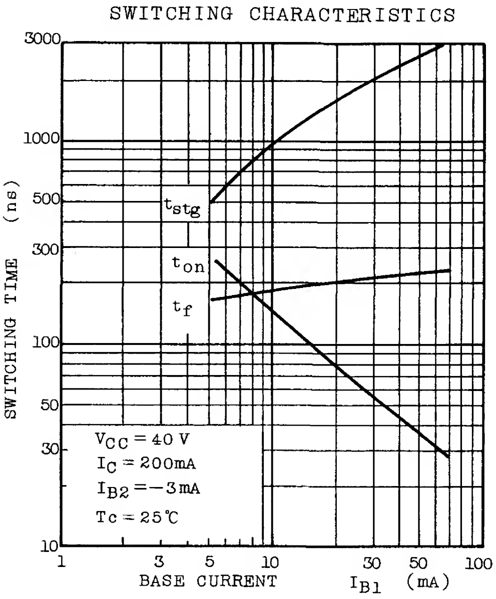
MAXIMUM RATINGS (Ta=25°C)

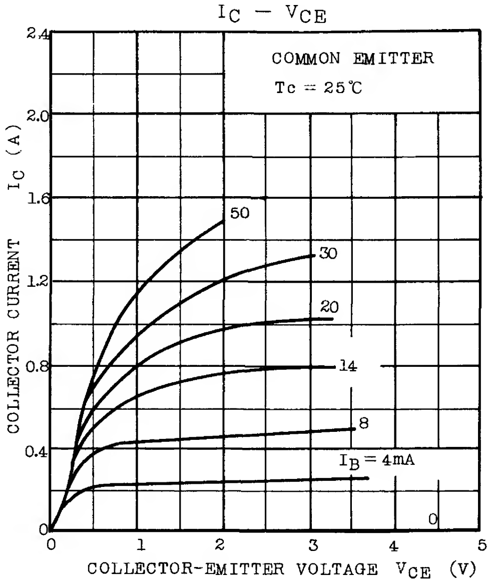
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC522	V_{CBO}	140	V
	2SC524		100	
Collector-Emitter Voltage	2SC522	V_{CEO}	100	V
	2SC524		60	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	300	mA
Collector Power Dissipation (Tc=25°C)		P_C	10	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65∿175	°C

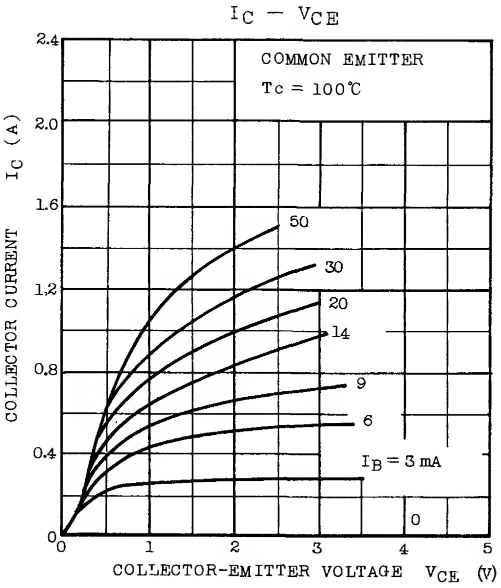
ELECTRICAL CHARACTERISTICS (Ta=25°C)

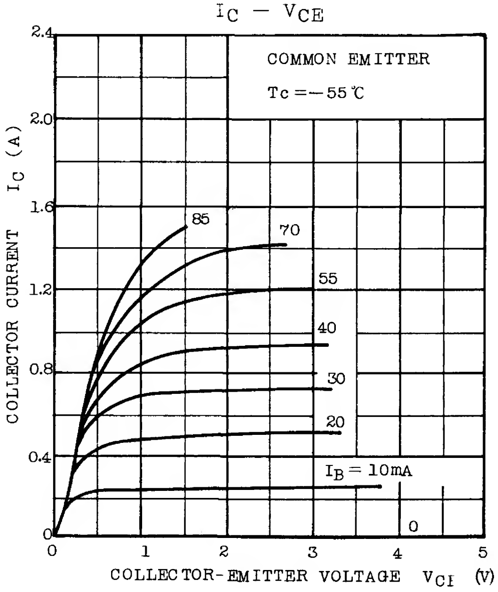
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	–	–	1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	–	–	10	μA
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=200mA	30	–	150	
		$h_{FE(2)}$	V_{CE}=5V, I_C=1A	15	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=200mA, I_B=20mA	–	0.2	0.6	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=200mA, I_B=20mA	–	0.8	1.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=30mA	20	60	–	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	–	25	40	pF
Switching Time	Turn-on Time	t_{on}	 20V 0 10μS INPUT 1kΩ 1kΩ OUTPUT 200Ω V_{BB}=−3V V_{CC}=40V DUTY CYCLE≦2%	–	0.13	–	μs
	Storage Time	t_{stg}		–	3	–	
	Fall Time	t_f		–	0.2	–	

Note : $h_{FE(1)}$ Classification R : 30∿90, 0 : 50∿150

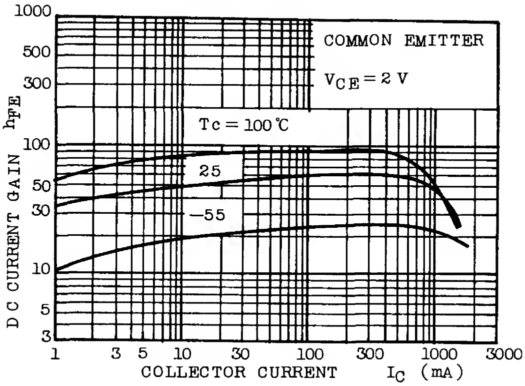

SWITCHING CHARACTERISTICS
3000
1000
500
300
100
50
30
10
SWITCHING TIME (ns)
t_{stg}
t_{on}
t_f
V_{CC} = 40 V
I_C = 200mA
I_{B2} = −3mA
Tc = 25℃
1
3
5
10
30
50
100
BASE CURRENT I_{B1} (mA)


I_C − V_{CE}
COMMON EMITTER
Tc = 25℃
2.4
2.0
1.6
1.2
0.8
0.4
0
COLLECTOR CURRENT I_C (A)
50
30
20
14
8
I_B = 4mA
0
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

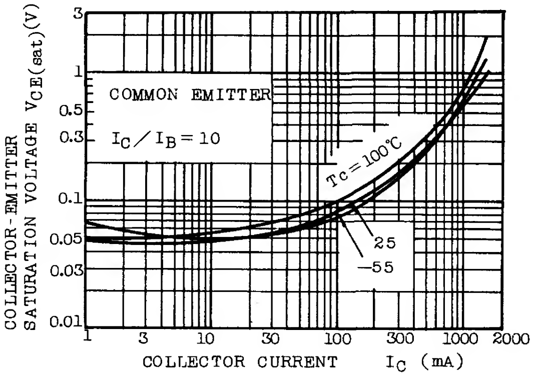

I_C − V_{CE}
COMMON EMITTER
Tc = 100℃
2.4
2.0
1.6
1.2
0.8
0.4
0
COLLECTOR CURRENT I_C (A)
50
30
20
14
9
6
I_B = 3 mA
0
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


I_C − V_{CE}
COMMON EMITTER
Tc = −55℃
2.4
2.0
1.6
1.2
0.8
0.4
0
COLLECTOR CURRENT I_C (A)
85
70
55
40
30
20
I_B = 10mA
0
0
1
2
3
4
5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

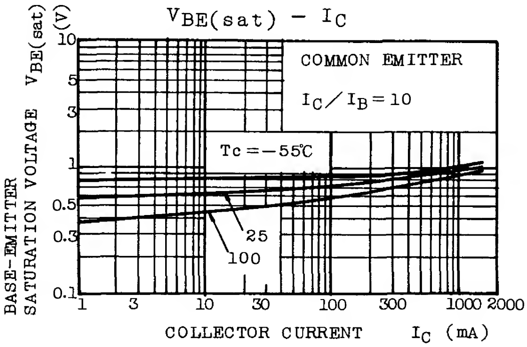
h_{FE} − I_C



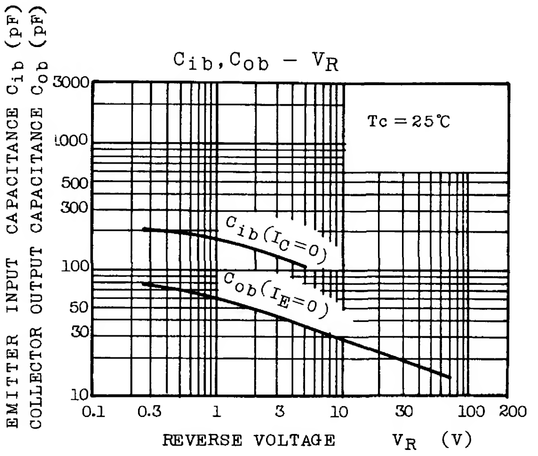
$V_{CE(sat)}$ − I_C



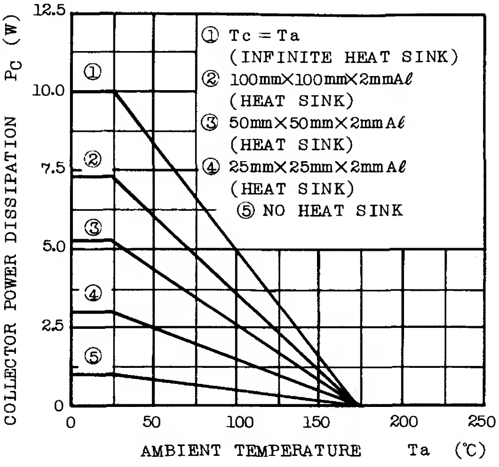
$V_{BE(sat)}$ − I_C



C_{ib}, C_{ob} − V_R



P_C − Ta



2SC594

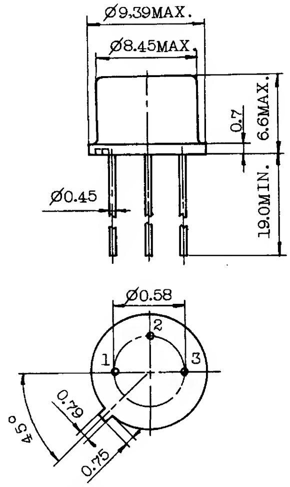
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH FREQUENCY AMPLIFIER APPLICATIONS.
VIDEO AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=200MHz (Typ.)
- Low Output Capacitance : C_{ob}=3.5pF (Typ.)
- Low Saturation Voltage
  : $V_{CE(sat)}$=0.3V (Max.) at I_C=100mA, I_B=10mA
- Complementary to 2SA594.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

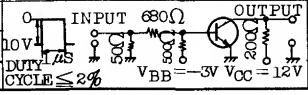
JEDEC	TO − 39
EIAJ	TC − 5, TB − 5B
TOSHIBA	2 − 8B1A

Weight : 1.13g

MAXIMUM RATINGS (Ta=25°C)

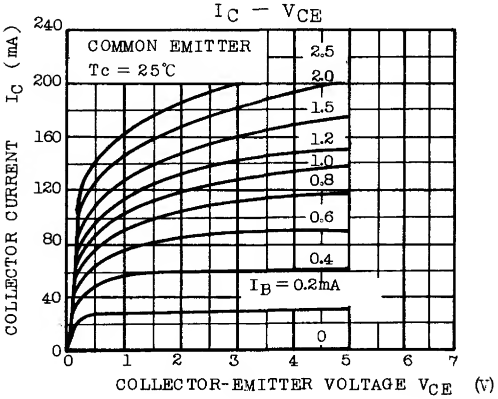
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	45	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	200	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	P_C	750	mW
	Tc=25°C		5	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

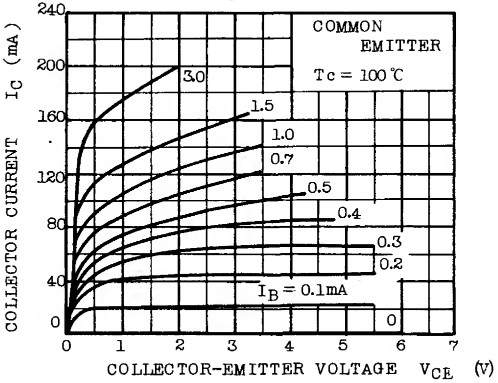
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=45V, I_E=0	−	−	0.1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	0.1	μA
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=10mA	40	−	240	
		$h_{FE(2)}$	V_{CE}=3V, I_C=200mA	20	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=100mA, I_B=10mA	−	−	0.3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=100mA, I_B=10mA	−	−	1.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=10mA	100	200	−	MHz
Input Impedance (Real Part)		r_{ie}	V_{CE}=10V, I_E=−10mA, f=200MHz	−	−	120	Ω
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	3.5	5.0	pF
Switching Time	Turn-on Time	t_{on}	 INPUT 680Ω OUTPUT 10V 1μS DUTY CYCLE≤2% 50Ω 200Ω VBB=−3V VCC=12V	−	30	−	ns
	Storage Time	t_{stg}		−	250	−	
	Fall Time	t_f		−	30	−	

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240,

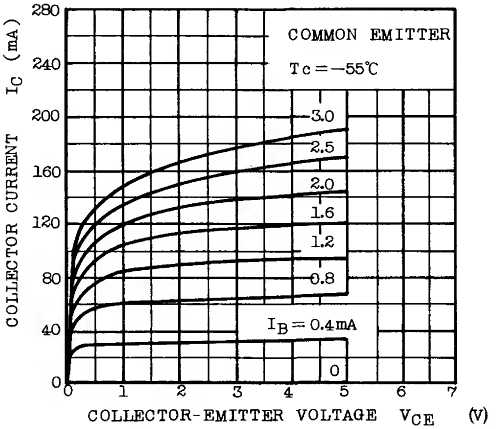
$I_C - V_{CE}$



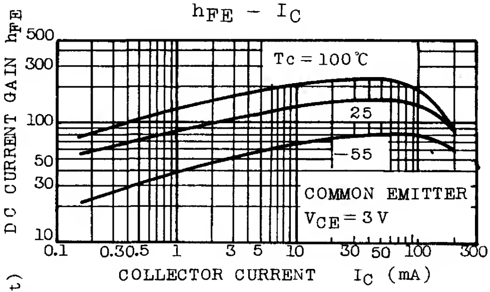
$I_C - V_{CE}$



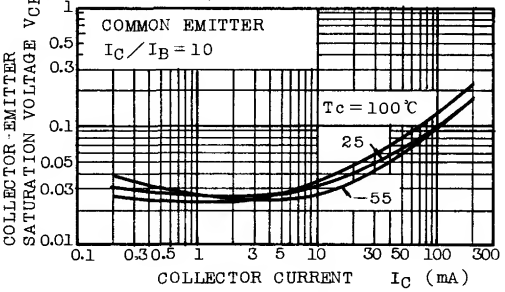
$I_C - V_{CE}$



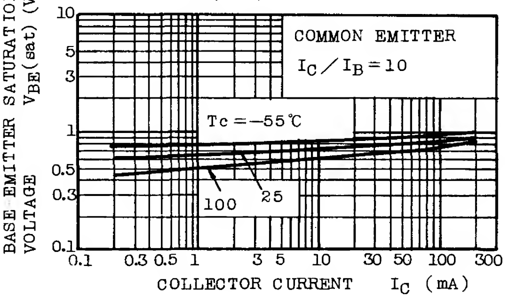
$h_{FE} - I_C$



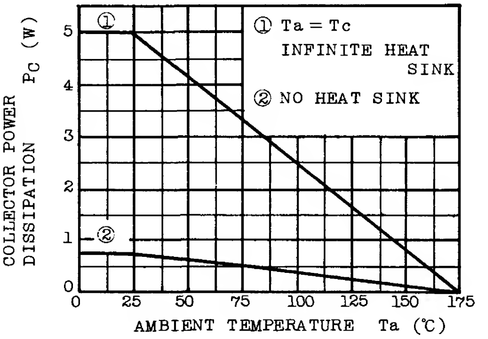
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Ta$



2SC790

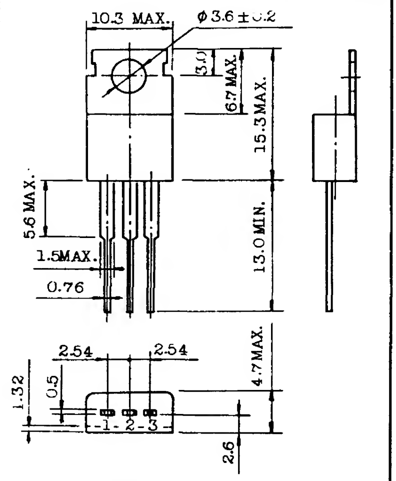
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA490.
- Recommended for 10W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	40	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Emitter Current	I_E	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ∿ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=30V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=2V, I_C=2A	13	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.2A	-	0.25	1.4	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=2A	-	0.85	1.8	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	3	10	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	85	-	pF

Note: $h_{FE(1)}$ Classification R : 40 ∿ 80, O : 70 ∿ 140, Y : 120 ∿ 240

SILICON NPN EPITAXIAL PLANAR TYPE

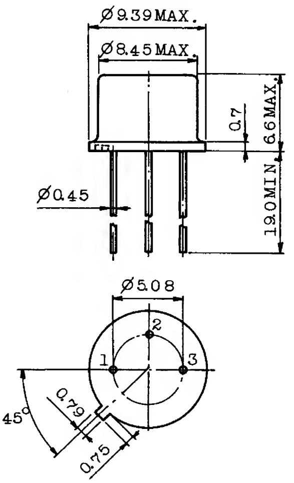
2SC994

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : Po=0.95W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=40mW)

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (CASE)

JEDEC	TO−39
EIAJ	TC−5, TB−5B
TOSHIBA	2−8B1A

Weight : 1.1g

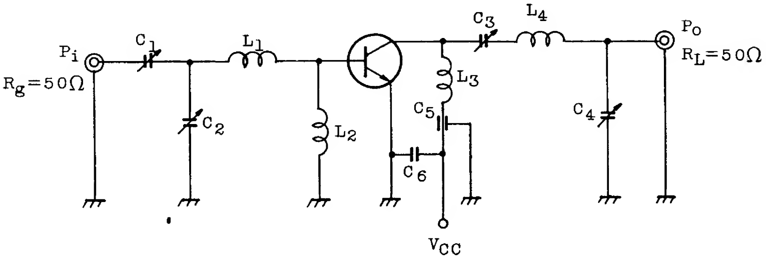
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	15	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current	I_C	0.1	A
Collector Power Dissipation (Ta=25°C)	P_C	0.6	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	−65~175	°C

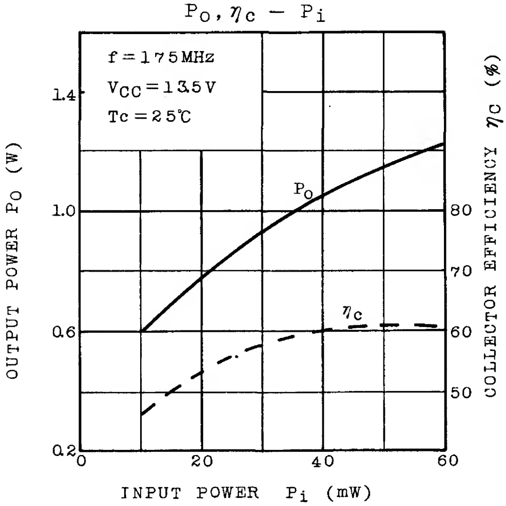
ELECTRICAL CHARACTERISTICS (Ta=25°C)

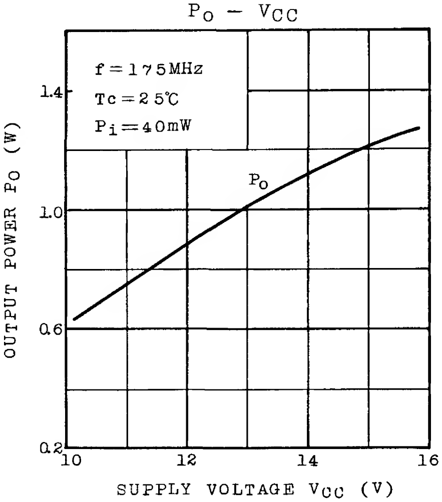
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	−	−	1.0	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=0.1mA, I_E=0	36	−	−	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	15	−	−	V
DC Current Gain	h_{FE}	V_{CE}=3V, I_C=100mA	20		400	−
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	3.8	5	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=40mW	0.95	1.05	−	W
Power Gain	G_{pe}		13.7	14.2	−	dB

Fig. P_O TEST CIRCUIT



C_1, C_2, C_3, C_4 : 3.5 ~30pF
C_5 : 0.001μF FEED THROUGH
C_6 : 0.05μF CERAMIC CONDENSER
L_1, L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T
L_2 : 1μH CHOLK COIL
L_4 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

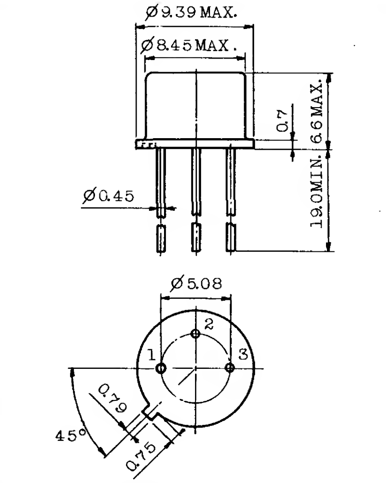
2SC1001

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

. Output Power : P_O=1.2W(Min.)
(f=470MHz, V_{CC}=12.6V, P_i=0.3W)

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1B

Weight : 1.2g

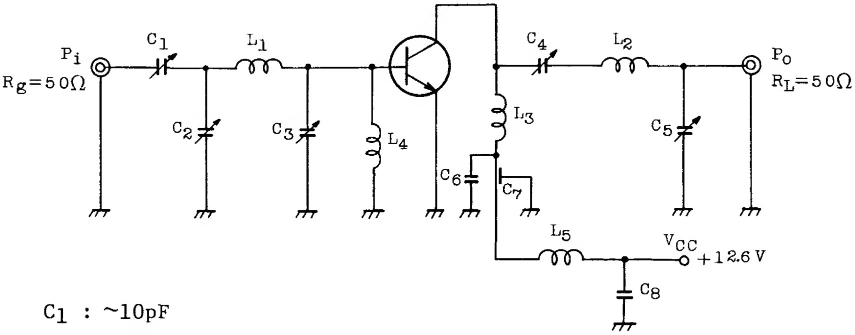
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	6.5	10	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=0.3W	1.2	1.5	-	W
Power Gain	G_{pe}		6	7	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=1.2W	-	5+j6.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	22-j25	-	Ω

Fig. P_o TEST CIRCUIT



C_1 : ~10pF

C_2,C_5 : ~30pF

C_3,C_4 : ~25pF

C_6,C_8 : 0.01μF

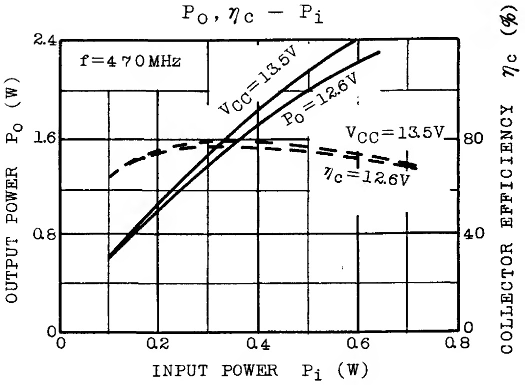
C_7 : 1000pF

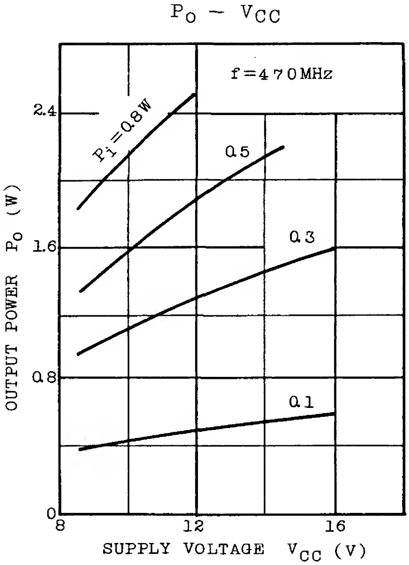
L_1 : ϕ0.8 SILVER PLATED COPPER WIRE, 6ID, 2T

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 25 LENGTH, STRAIGHT

L_3 : ϕ1 SILVER PLATED COPPER WIRE, 20 LENGTH, STRAIGHT

L_4,L_5 : RFC





SILICON NPN EPITAXIAL PLANAR TYPE

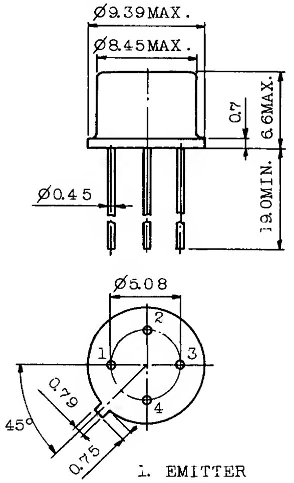
2SC1164

HIGH POWER AMPLIFIER FOR CATV APPLICATIONS.

FEATURES:

- Wide Band and High Gain for Class A Amplifier.
- Excellent Cross Modulation Characteristics.
- All Electrodes Insulated from Case.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

JEDEC	TO-33
EIAJ	TC-5, TB-14B
TOSHIBA	2-8D1A

Weight : 1.2g

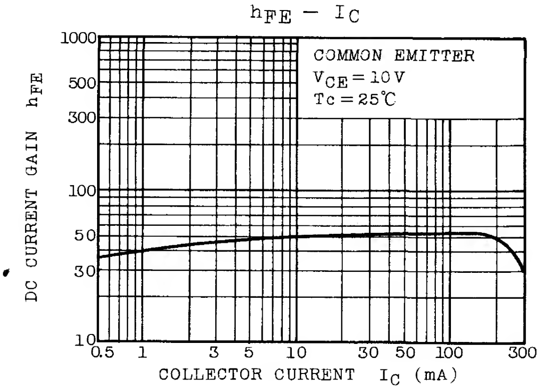
MAXIMUM RATINGS (Ta=25°C)

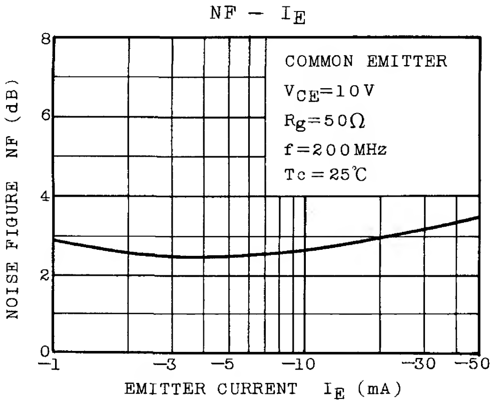
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current	I_C	300	mA
Collector Power Dissipation	P_C	600	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~150	°C

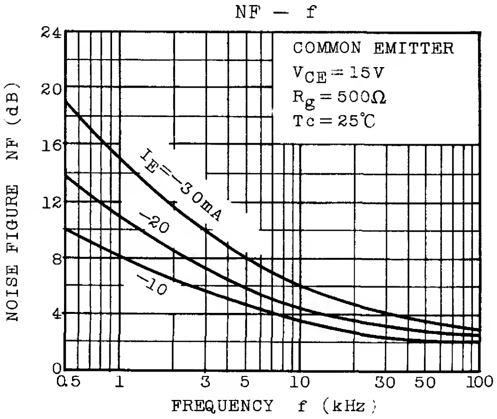
ELECTRICAL CHARACTERISTICS (Ta=25°C)

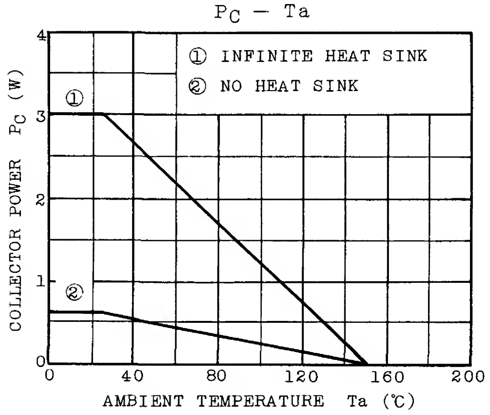
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=20V, I_E=0	-	-	0.3	μA
Collector-Emitter Breakdwon Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	35	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=10V, I_C=50mA	25	-	90	
Transition Frequency	f_T	V_{CE}=20V, I_E=-50mA	1100	1400	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=15V, I_E=0, f=1MHz	-	2.2	3.0	pF
Noise Figure	NF	V_{CE}=20V, I_C=10mA R_g=50Ω, f=200MHz	-	4.0	5.0	dB
Power Gain	G_{pe}	V_{CC}=20V, I_E=-50mA f=200MHz	10	14	-	dB

Note: h_{FE} Classification R:25∿50 O:45∿90


hFE — IC
COMMON EMITTER
VCE = 10V
Tc = 25℃
DC CURRENT GAIN hFE
1000
500
300
100
50
30
10
0.5
1
3
5
10
30
50
100
300
COLLECTOR CURRENT IC (mA)


NF — IE
COMMON EMITTER
VCE=10V
Rg=50Ω
f=200MHz
Tc = 25℃
NOISE FIGURE NF (dB)
8
6
4
2
0
−1
−3
−5
−10
−30
−50
EMITTER CURRENT IE (mA)


NF — f
COMMON EMITTER
VCE = 15V
Rg = 500Ω
Tc = 25℃
IE=−30mA
−20
−10
NOISE FIGURE NF (dB)
24
20
16
12
8
4
0
0.5
1
3
5
10
30
50
100
FREQUENCY f (kHz)


PC — Ta
① INFINITE HEAT SINK
② NO HEAT SINK
①
②
COLLECTOR POWER PC (W)
4
3
2
1
0
0
40
80
120
160
200
AMBIENT TEMPERATURE Ta (℃)

SILICON NPN EPITAXIAL PLANAR TYPE

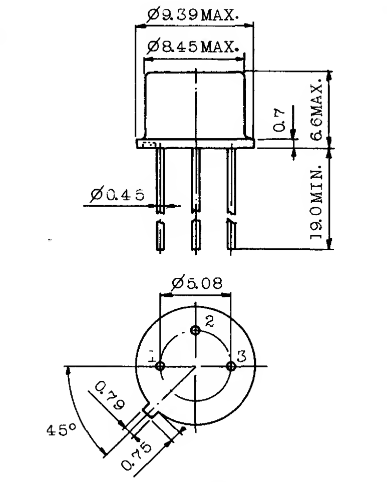
2SC1165

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=0.9W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=0.3W)
- All Electrodes Insulated from Case.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR

JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1C

Weight : 1.2g

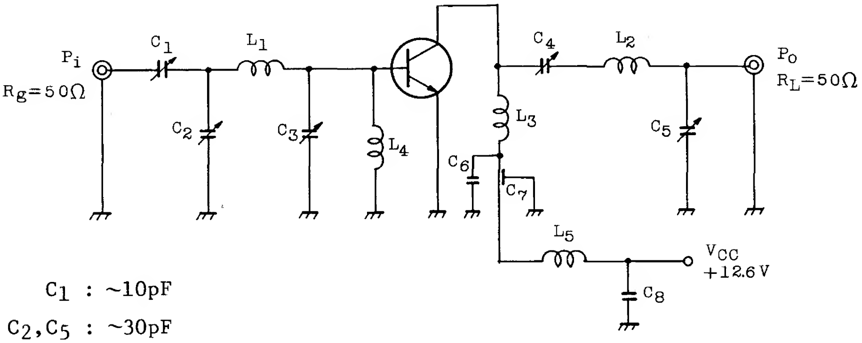
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Cueernt	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	6.5	10	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=0.3W	0.9	1.0	-	W
Power Gain	G_{pe}		4.7	5.2	-	dB
Collector Efficiency	η_c		60	-	-	%

Fig. f=470MHz P_o TEST CIRCUIT



C_1 : ~10pF

C_2,C_5 : ~30pF

C_3,C_4 : ~25pF

C_5,C_8 : 0.01μF

C_7 : 1000pF

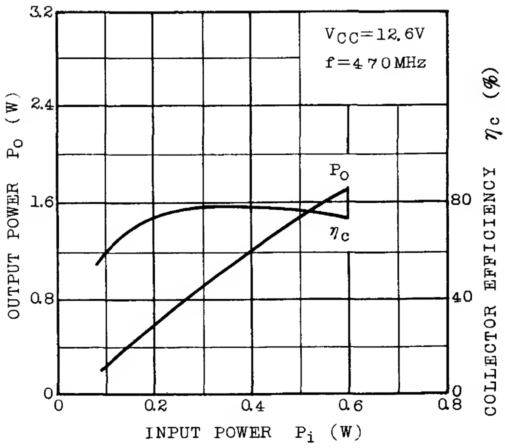
L_1 : φ0.8 SILVER PLATED COPPER WIRE, 6ID, 2T

L_2 : φ1 SILVER PLATED COPPER WIRE, 25 LENGTH, STRAIGHT

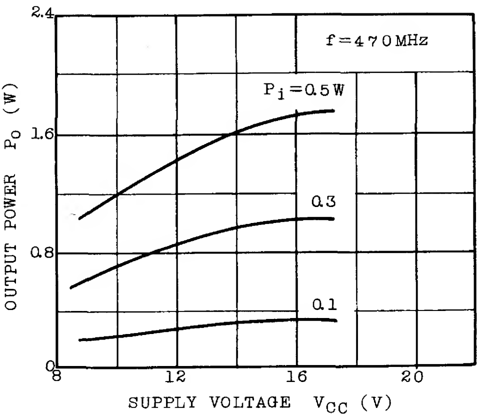
L_3 : φ1 SILVER PLATED COPPER WIRE, 20 LENGTH, STRAIGHT

L_4,L_5 : RFC

P_o, η_c − P_i



P_o − V_{CC}



SILICON NPN EPITAXIAL PLANAR TYPE

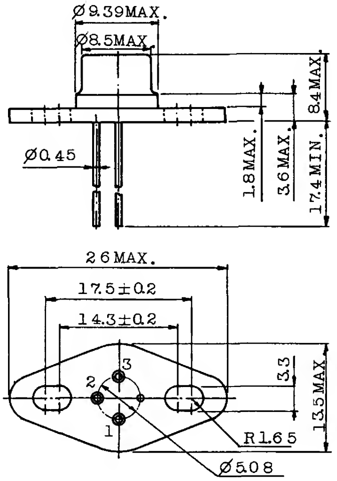
2SC1169

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=2.5W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=0.25W)

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2—9A1B

Weight : 3.7g

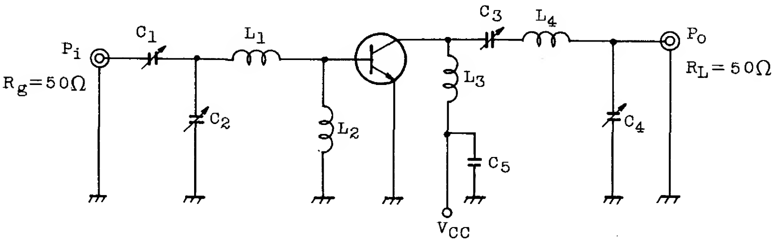
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	1	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	hFE	VCE=5V, I_C=0.2A	20	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	6.5	10	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=0.25W	2.5	2.7	-	W
Power Gain	G_{pe}		10	10.3	-	dB
Collector Efficiency	η_c		60	73	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=13.5V, f=175MHz, P_o=2.5W	-	5.0 +j2.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	30 -j20	-	Ω

Fig. P_o TEST CIRCUIT



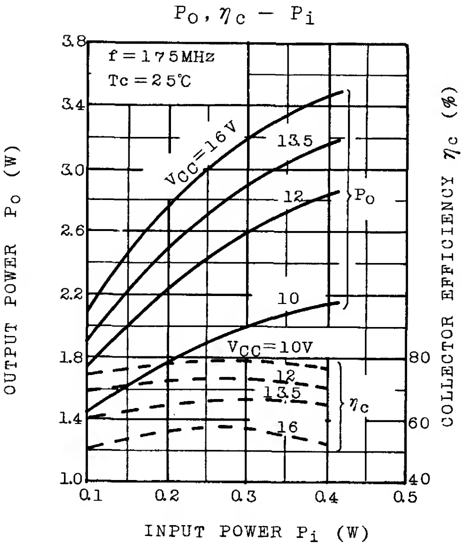
C_1, C_2, C_3, C_4 : 3.5 ~ 30pF

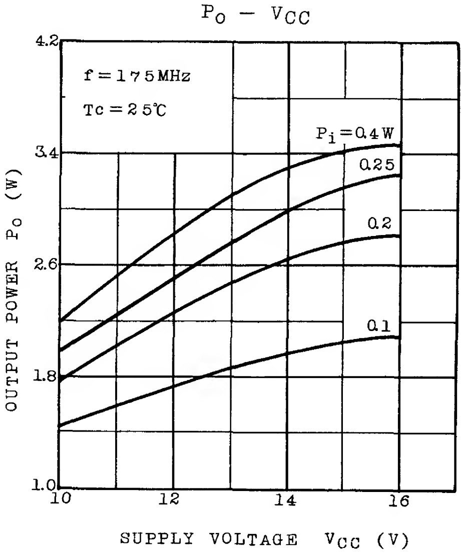
C_5 : 0.001μF FEED THROUGH AND 0.05μF CERAMIC CONDENSER

L_1, L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T

L_2 : 1μH CHOLK COIL

L_4 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 7/4T





SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

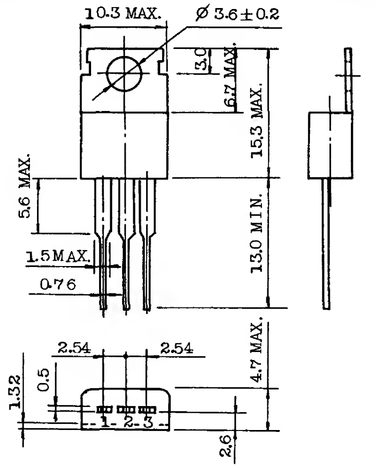
2SC1173

POWER AMPLIFIER APPLICATIONS.
CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}.
- Complementary to 2SA473 and 5 Watts Output Applications.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS

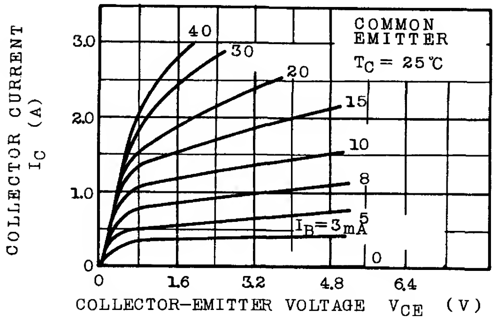
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Emitter Current	I_E	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ∿ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

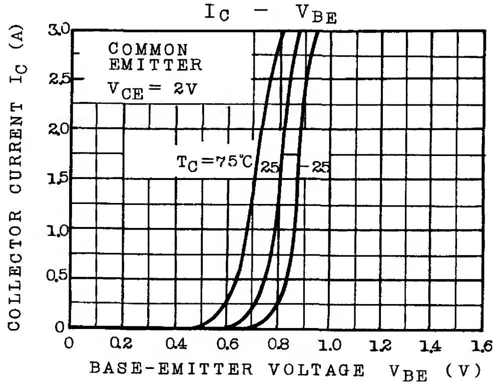
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=20V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=0.5A	70	-	240	
	$h_{FE(2)}$	V_{CE}=2V, I_C=2.5A	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.2A	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=0.5A	-	0.75	1.0	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	35	-	pF

Note: $h_{FE(1)}$ Classification O : 70 ∿ 140, Y : 120 ∿ 240

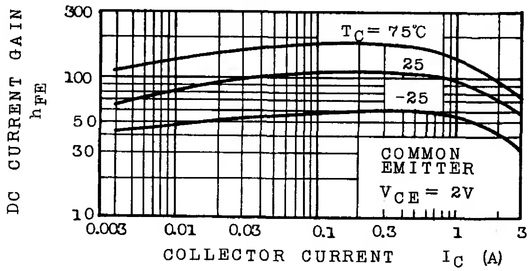
I_C – V_{CE}



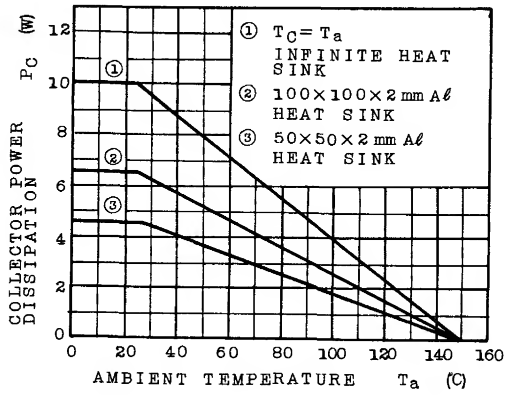
I_C – V_{BE}



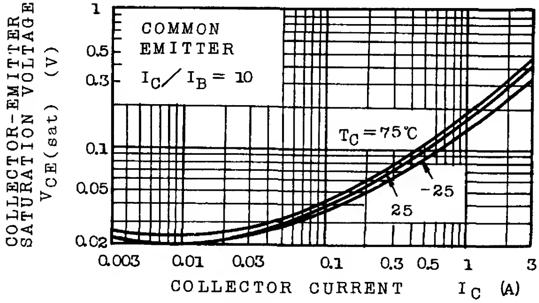
h_{FE} – I_C



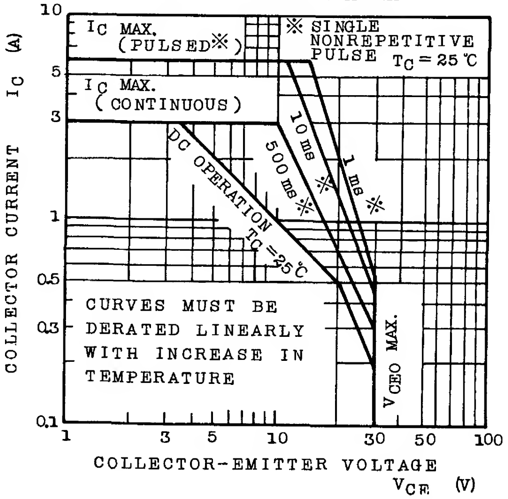
P_C – T_a



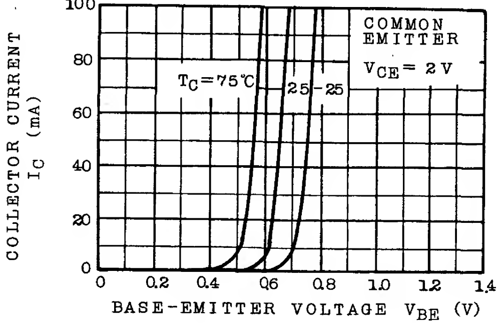
$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



I_C–V_{BE} (LOW CURRENT REGION)



SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

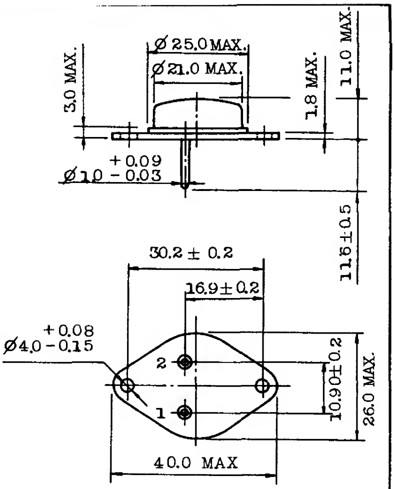
2SC1195

REGULATOR APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=200V
- Large Collector Current : I_C=2.5A
- Wide Safe Operating Area.



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21A1A

Mounting kit No. AC73
Weight : 12.0g

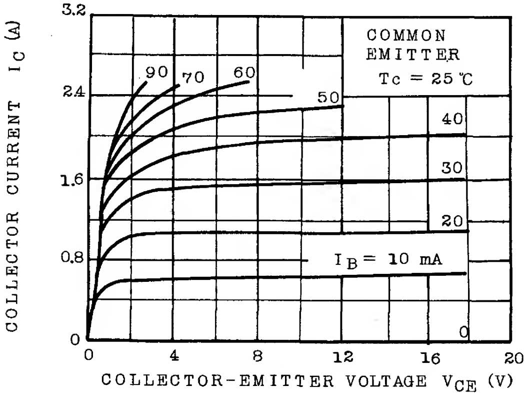
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	V_{CEO}	200	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation (T_C=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ∿ 150	°C

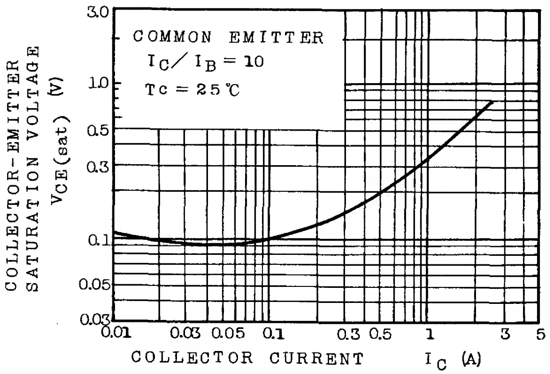
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	10	μA
	I_{CEO}	V_{CE}=200V, I_B=0	-	-	0.1	mA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	200	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	30	50	150	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=1A, I_B=0.1A	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=1A, I_B=0.1A	-	-	1.5	V

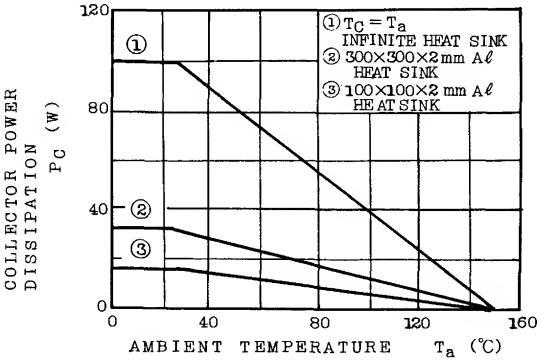
$I_C - V_{CE}$



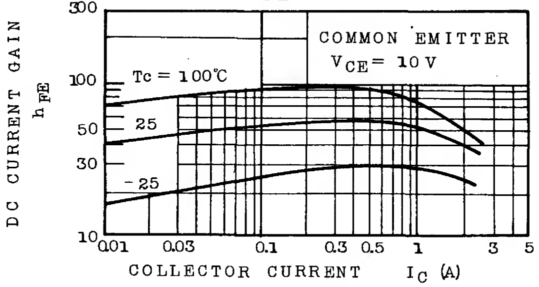
$V_{CE(sat)} - I_C$



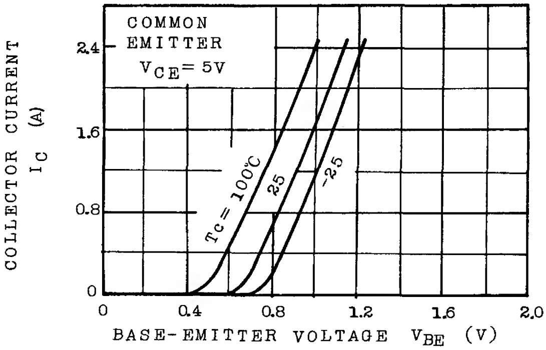
$P_C - T_a$



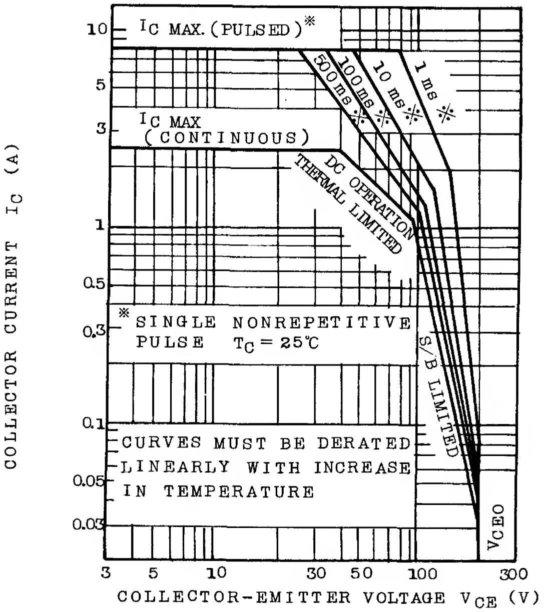
$h_{FE} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA



SILICON NPN EPITAXIAL PLANAR TYPE

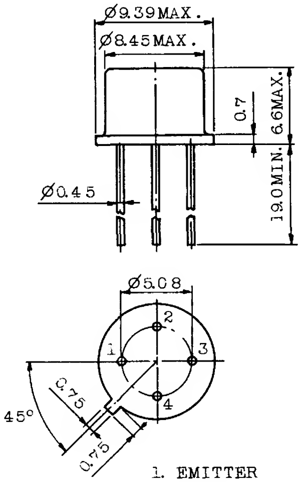
2SC1199

HIGH FREQUENCY WIDE BAND AMPLIFIER APPLICATIONS.
HIGH FREQUENCY LOW NOISE AMPLIFIER APPLICATIONS.

FEATURES:

. Low Noise for High and Low Frequency
: NF=4.0dB(Max.)   f=200MHz
: NF=11dB (Max.)   f=10kHz

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

JEDEC	TO-33
EIAJ	TC-5, TB-14B
TOSHIBA	2-8D1A

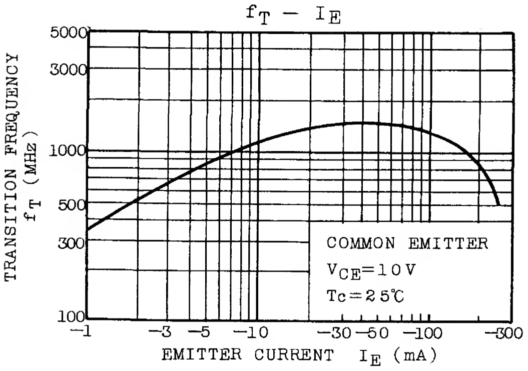
Weight : 1.2g

MAXIMUM RATINGS (Ta=25°C)

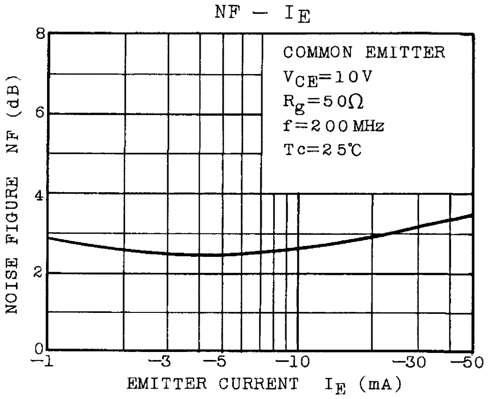
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current	I_C	300	mA
Collector Power Dissipation	P_C	600	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-65 ~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

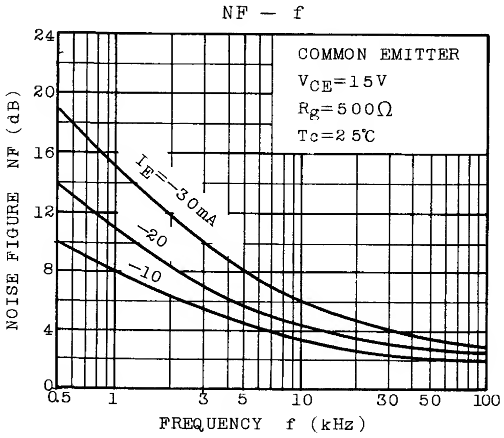
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=20V, I_E=0	-	-	0.1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=0.1mA, I_E=0	50	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=1mA, I_B=0	35	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3	-	-	V
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=20mA	40	80	200	
Transition Frequency	f_T	V_{CE}=10V, I_E=-20mA	1000	1400	-	MHz
Collector Output Capacitance	Cob	V_{CB}=15V, I_E=0, f=1MHz	-	2.2	3.0	pF
Noise Figure	NF(1)	V_{CE}=10V, I_E=-10mA, R_g=50Ω, f=200MHz	-	2.5	4.0	dB
	NF(2)	V_{CE}=15V, I_E=-30mA, R_g=500Ω, f=10kHz	-	6	11	dB



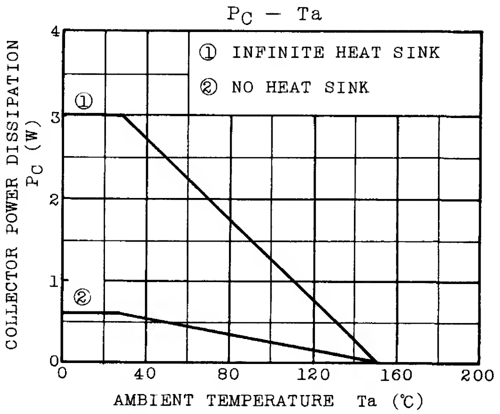
fT − IE
TRANSITION FREQUENCY fT (MHz)
5000
3000
1000
500
300
100
−1
−3
−5
−10
−30
−50
−100
−300
EMITTER CURRENT IE (mA)
COMMON EMITTER
VCE=10V
Tc=25℃



NF − IE
NOISE FIGURE NF (dB)
8
6
4
2
0
−1
−3
−5
−10
−30
−50
EMITTER CURRENT IE (mA)
COMMON EMITTER
VCE=10V
Rg=50Ω
f=200MHz
Tc=25℃



NF − f
NOISE FIGURE NF (dB)
24
20
16
12
8
4
0
0.5
1
3
5
10
30
50
100
FREQUENCY f (kHz)
COMMON EMITTER
VCE=15V
Rg=500Ω
Tc=25℃
IE=−30mA
−20
−10



PC − Ta
COLLECTOR POWER DISSIPATION PC (W)
4
3
2
1
0
40
80
120
160
200
AMBIENT TEMPERATURE Ta (℃)
① INFINITE HEAT SINK
② NO HEAT SINK
①
②

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

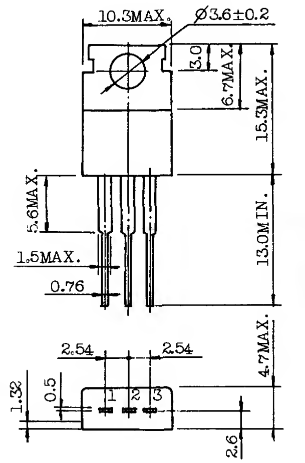
2SC1569

COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=300V
- Small Collector Output Capacitance : C_{ob}=5.0pF(Typ.)
- High Transition Frequency : f_T=100MHz (Typ.)

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDED	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

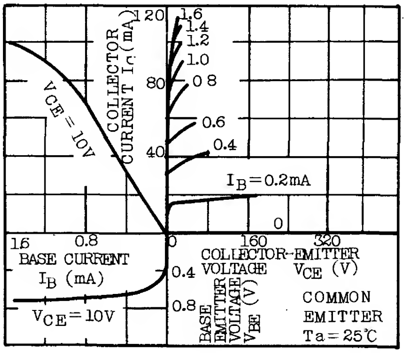
Mounting kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

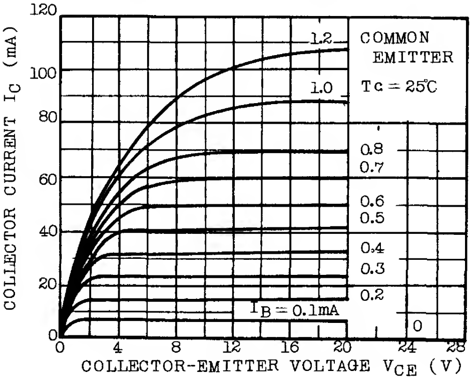
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	300	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	150	mA
Emitter Current		I_E	-150	mA
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		12.5	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

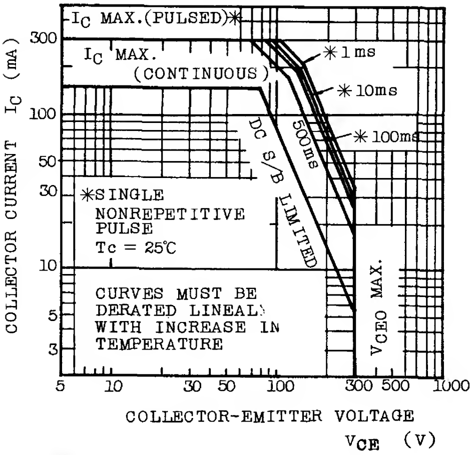
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	300	-	-	V
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=50mA	40	-	170	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=100mA, I_B=20mA	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=100mA, I_B=20mA	-	-	1.2	V
Transition Frequency	f_T	V_{CE}=10V, I_C=30mA	40	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	5.0	6.5	pF



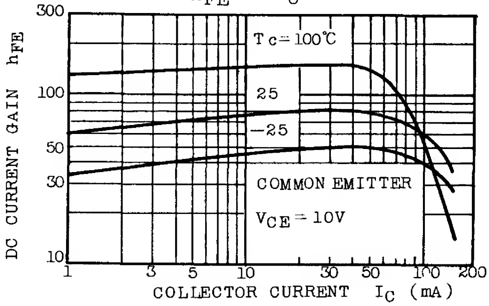
STATIC CHARACTERISTICS



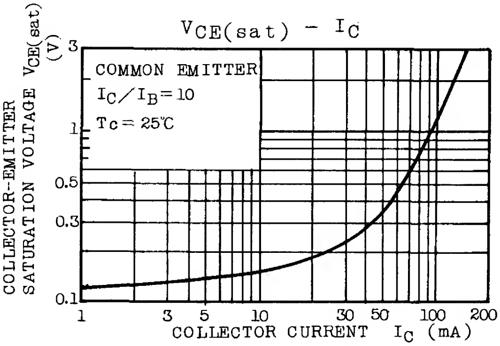
I_C - V_{CE} (LOW VOLTAGE REGION)



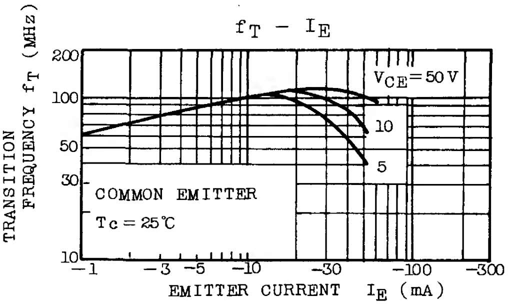
SAFE OPERATING AREA



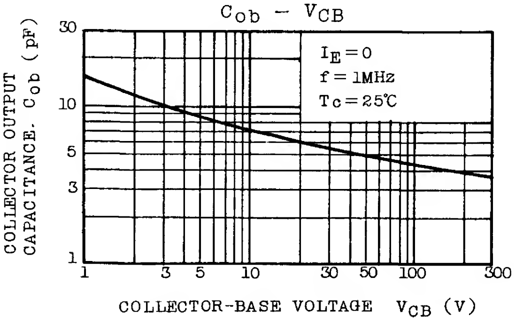
h_{FE} - I_C



$V_{CE(sat)}$ - I_C



f_T - I_E



C_{ob} - V_{CB}

SILICON NPN TRIPLE DIFFUSED TYPE

2SC1576

REGULATOR APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

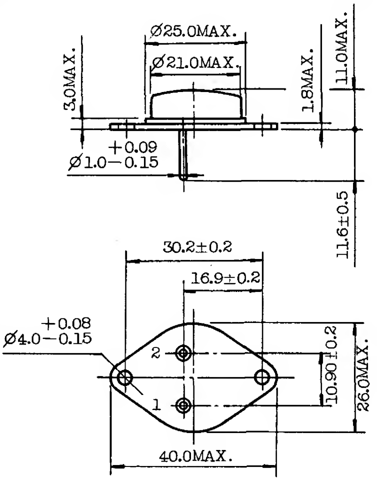
- High Voltage : V_{CBO}=450V
- Low Saturation Voltage :
  : $V_{CE(sat)}$= 1.5V (Max.) (I_C=5A, I_B=0.8A)
- High Speed Switching Time : t_{stg}=3.0µs (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	450	V
Collector-Emitter Voltage	V_{CEO}	330	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	8	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

INDUSTRIAL APPLICATIONS

Unit in mm



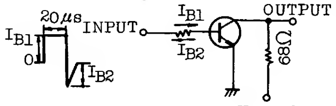
1. BASE
2. EMITTER

COLLECTOR (CASE)

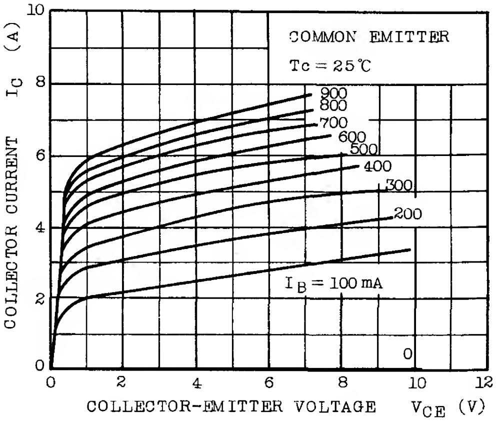
JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting Kit No. AC73
Weight : 12.9g

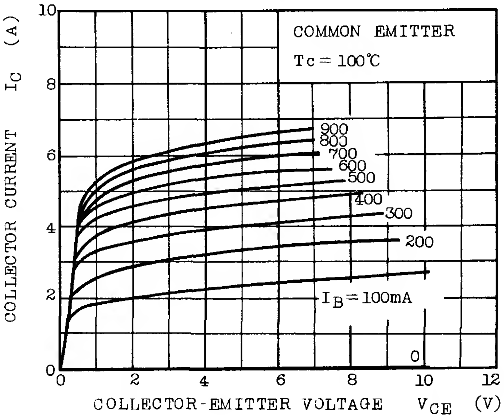
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=450V, I_E=0	−	−	100	µA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	−	−	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=5mA, I_B=0	330	−	−	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=1A	30	−	150	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=0.8A	−	−	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=0.8A	−	−	1.8	V
Switching Time	Turn-on Time	t_{on}	 20µs INPUT I_{B1} 0 I_{B2} I_{B1} I_{B2} OUTPUT 68Ω V_{CC}=200V $I_{B1}=-I_{B2}$=0.3A DUTY CYCLE≦2%	−	1.0	−	µs
	Storage Time	t_{stg}		−	3.0	−	
	Fall Time	t_f		−	0.8	−	

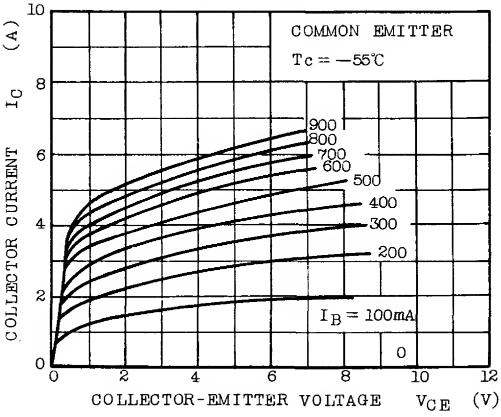
I_C – V_{CE}



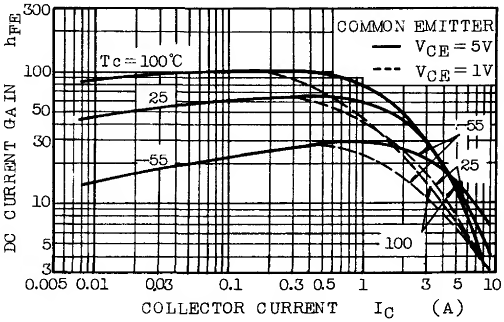
I_C – V_{CE}



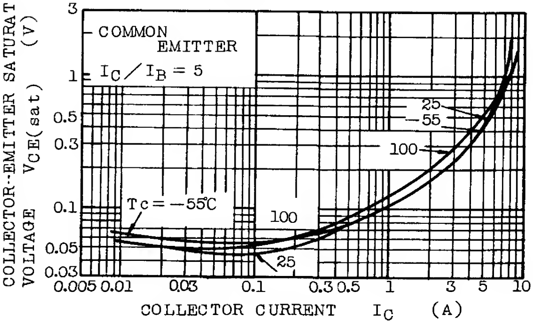
I_C – V_{CE}



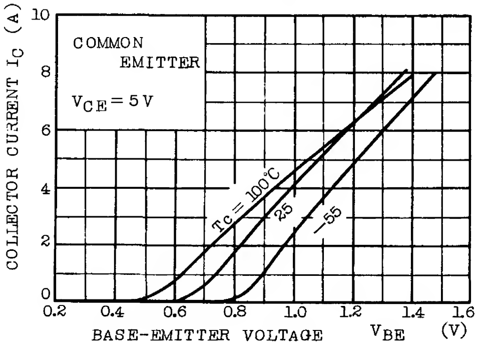
h_{FE} – I_C



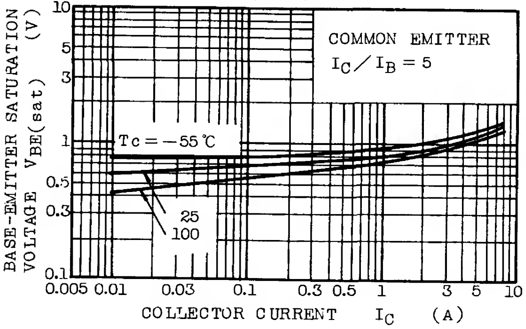
$V_{CE(sat)}$ – I_C



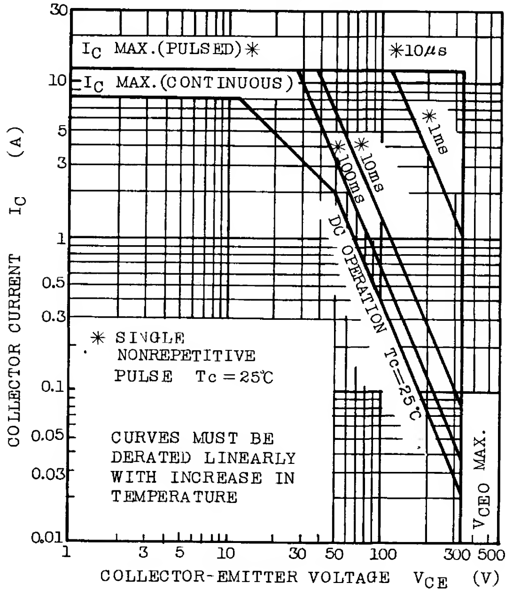
I_C – V_{BE}



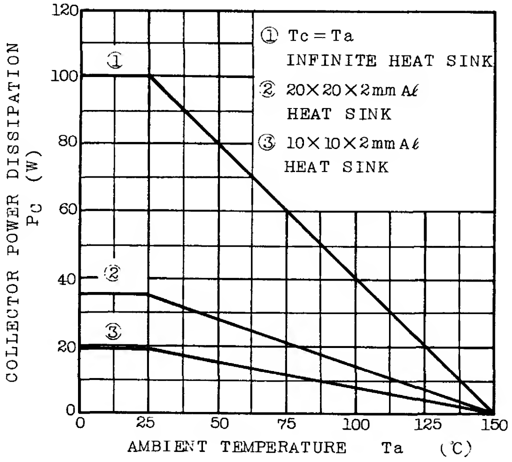
$V_{BE(sat)}$ – I_C



SAFE OPERATING AREA



P_C – Ta



2SC1617

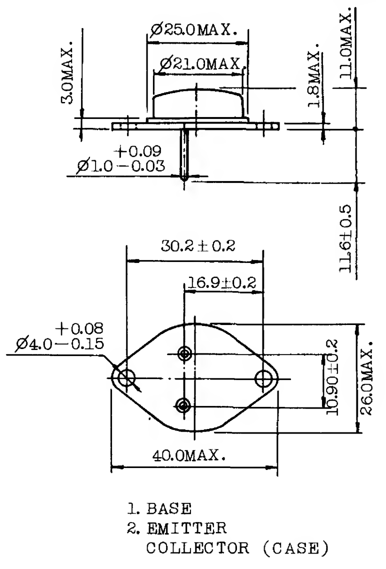
SILICON NPN TRIPLE DIFFUSED TYPE

BLACK AND WHITE TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES;

- High Voltage : V_{CBO}=300V
- Wide Safe Oprating Area.

Unit in mm



JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting kit No. AC73
Weight : 12.0g

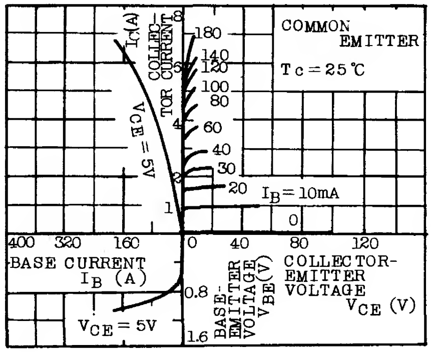
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector Power Dissipation	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

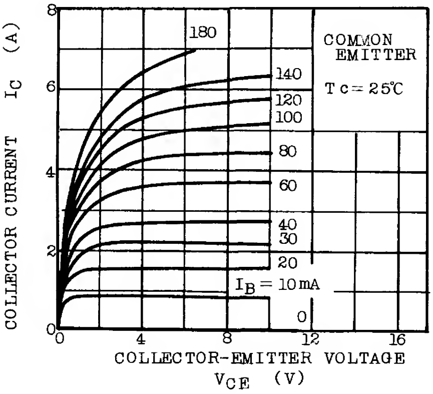
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=250V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	mA
DC Current Gain		$h_{FE}(1)$	V_{CE}=5V, I_C=1A	30	-	150	
		$h_{FE}(2)$	V_{CE}=5V, I_C=7A	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.2	V
	Base-Emitter	$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	10	-	MHz

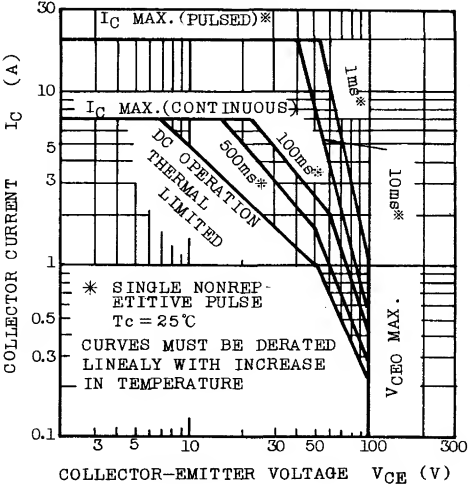
STATIC CHARACTERISTICS



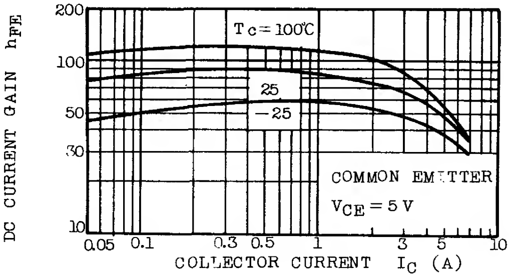
I_C – V_{CE} (LOW VOLTAGE REGION)



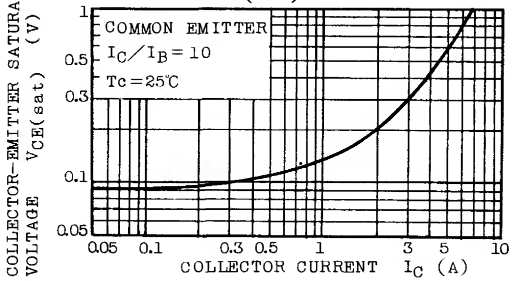
SAFE OPERATING AREA



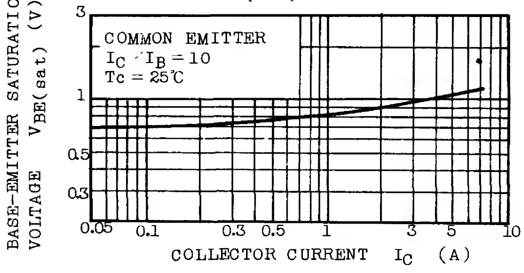
h_{FE} – I_C



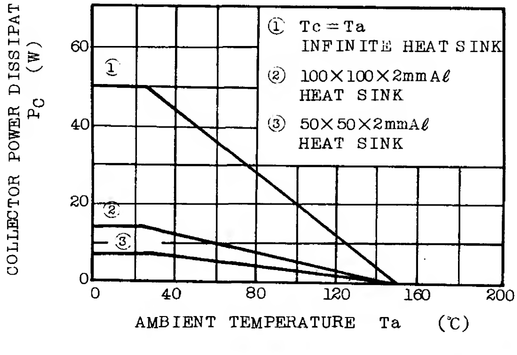
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



P_C – Ta



2SC1624
2SC1625

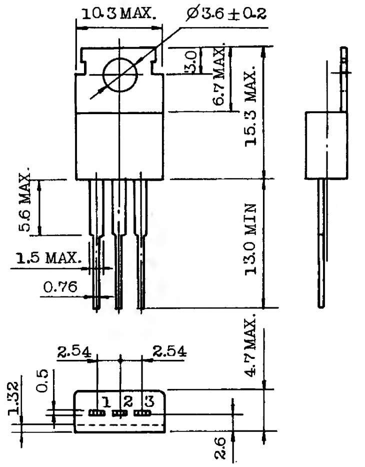
SILICON NPN PLANAR TYPE

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

High Breakdown Voltage : V_{CEO}=120V (2SC1624)
Complementary to 2SA814 and 2SA815.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

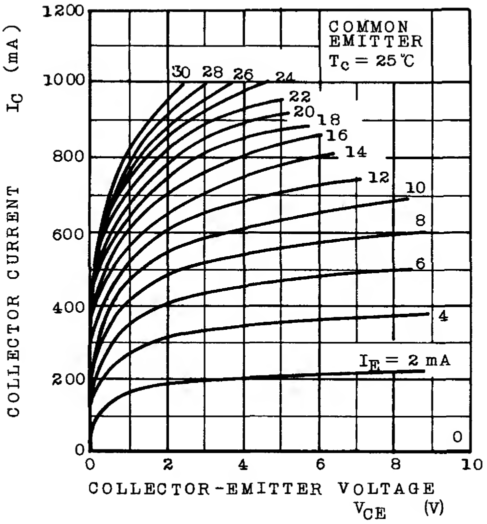
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC1624	V_{CBO}	120	V
	2SC1625		100	
Collector-Emitter Voltage	2SC1624	V_{CEO}	120	V
	2SC1625		100	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1	A
Emitter Current		I_E	-1	A
Collector Power Dissipation (Tc=25°C)		P_C	15	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

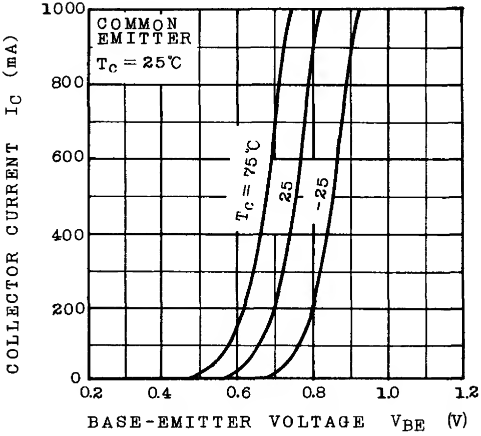
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	2SC1624	$V_{(BR)CEO}$	I_C=10mA, I_B=0	120	-	-	V
	2SC1625			100	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=150mA	70	-	240	
		$h_{FE(2)}$	V_{CE}=5V, I_C=500mA	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	0.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=150mA	10	30	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1 MHz	-	20	-	pF

Note : $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

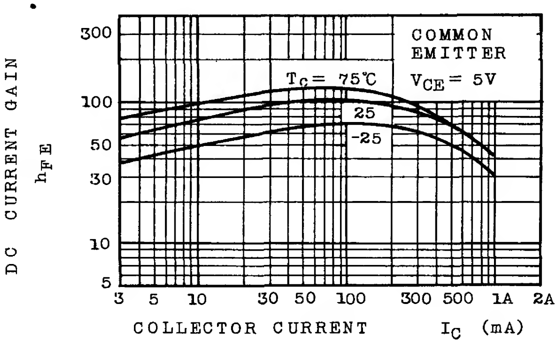
I_C – V_{CE}



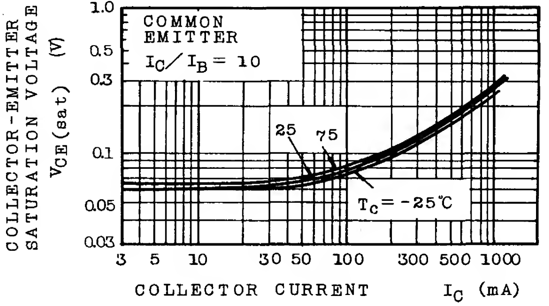
I_C – V_{BE}



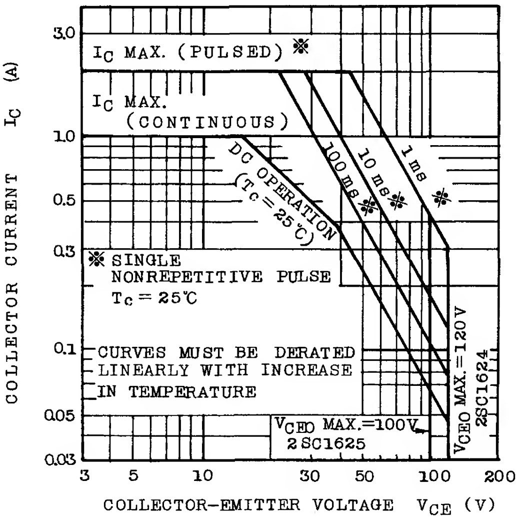
h_{FE} – I_C



$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



2SC1626

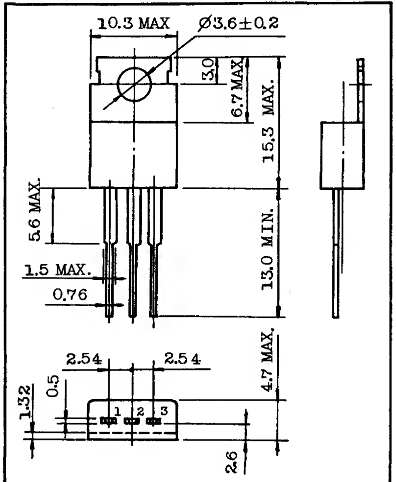
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=80V
- Complementary to 2SA816.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit NO. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RAINGS	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	750	mA
Emitter Current	I_E	-750	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	0.5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	5	-	-	
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=150mA	70	-	240	
		$h_{FE(2)}$	V_{CE}=2V, I_C=500mA	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	0.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=2V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=2V, I_C=150mA	50	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	15	-	pF

Note : $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

SILICON NPN EPITAXIAL PLANAR TYPE

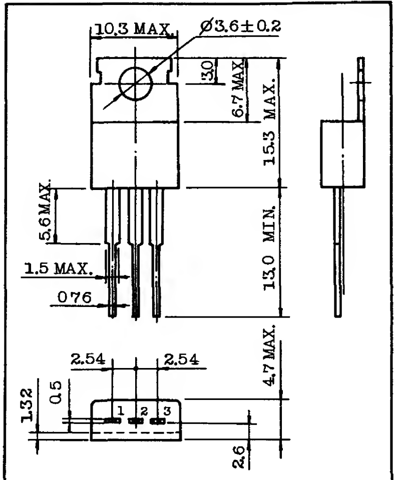
2SC1678

27 MHz POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Recommended for Output Stage Application of AM 4W Transmitter.
- High Power Gain.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JIDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

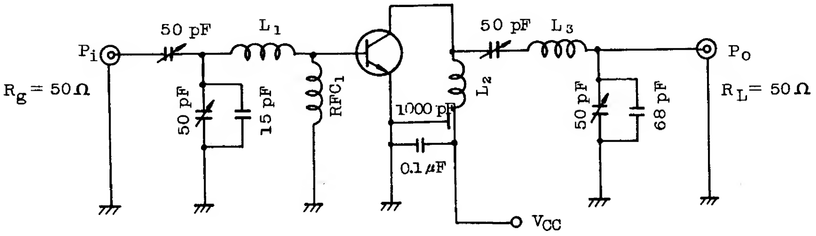
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage R_{BE}=10Ω	V_{CER}	65	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	3	A
Base Current	I_B	0.4	A
Emitter Current	I_E	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ∿ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_C=0	-	-	10	μA
Collector Cut-off Current		I_{CEO}	V_{CE}=20V, I_B=0	-	-	100	μA
Breakdown Voltage	Collector-Base	$V_{(BR)CBO}$	I_C=1.0mA, I_E=0	65	-	-	V
	Collector-Emitter	$V_{(BR)CER}$	I_C=10mA, R_{BE}=10Ω	65	-	-	
	Emitter-Base	$V_{(BR)EBO}$	I_E=1.0mA, I_C=0	4.0	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=0.5A (Note)	15	-	-	
		$h_{FE(2)}$	V_{CE}=5V, I_C=1.5A (Note)	10	-	-	
Collector Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=0.5A, I_B=0.05A	-	0.5	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=100mA	100	-	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	30	45	pF
Output Power Fig.		P_o	V_{CC}=12V, P_i=0.4W I_{DC}=415mA(Typ.),f=27MHz	3.0	-	-	W

Note : Pulse Test : Pulse Width ≦ 300μs, Duty Cycly ≦ 2.0%

Fig. P_0 TEST CIRCUIT



L_1 : ∅ 0.5 mm ENAMEL COATED COPPER WIRE, 7 T, 8 mm I.D

L_2 : ∅ 0.5 mm ENAMEL COATED COPPER WIRE, 5 T, 8 mm I.D

L_3 : ∅ 0.3 mm ENAMEL COATED COPPER WIRE, 18 T, 6 mm I.D

RFC_1 : ∅ 0.2 mm ENAMEL COATED COPPER WIRE, 76 T, 5 mm I.D

SILICON NPN EPITAXIAL PLANAR TYPE

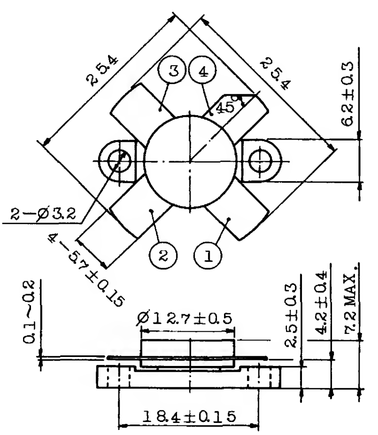
2SC1763

2 ~30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

FEATURES:

- Specified 28V, 28MHz Characteristics
  - : Output Power : P_O=40W_{PEP}
  - : Minimum Gain : G_{pe}=16dB
  - : Efficiency : η_c=40%(Min.)
  - : Intermodulation Distortion : IMD=-30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−13B1A

Weight : 5.2g

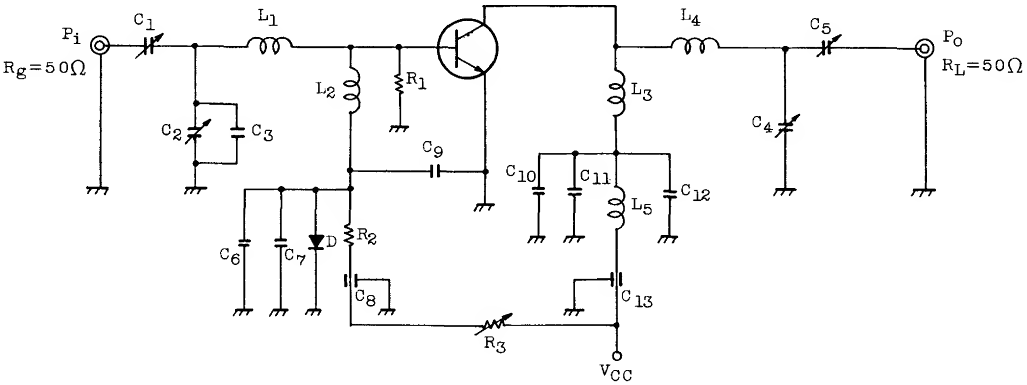
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	7	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	I_C=1mA, R_{BE}=10Ω	65	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=5A	10	-	-	
Transition Frequency	f_T	V_{CE}=15V, I_C=0.1A	50	-	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=28V, I_E=0, f=1MHz	-	110	150	pF
Power Gain	G_{pe}	V_{CC}=28V, f=28MHz 2-Tone, Δf=1kHz I_{idle}=20mA, P_o=40W_{PEP} (Fig.)	16	-	-	dB
Input Power	P_i		-	-	1	W_{PEP}
Collector Efficiency	η_c		40	-	-	%
Intermodulation Distortion	IMD		-	-	-30	dB

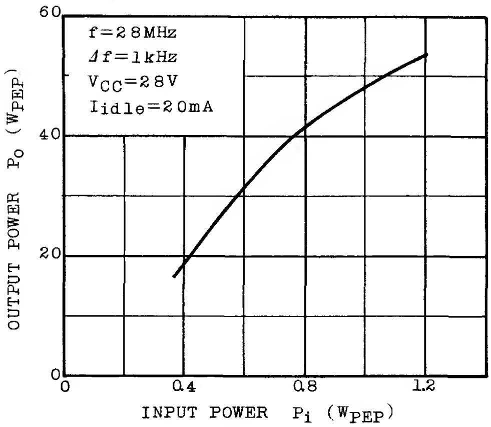
Fig. P_i TEST CIRCUIT



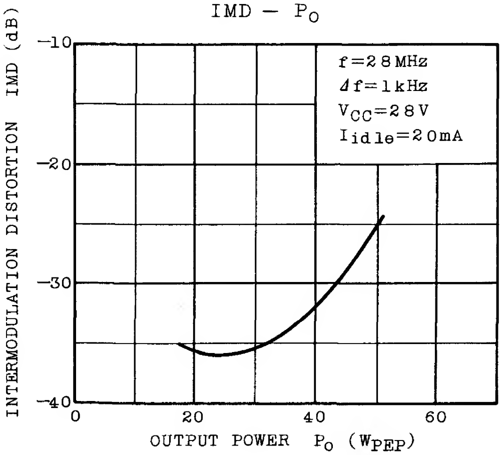
C_1, C_4, C_5 : ~100pF
C_2 : ~ 50pF
C_3 : 100pF
C_6, C_{10} : 0.1μF
C_7, C_{12} : 22μF
C_8, C_{13} : 6000pF FEED THROUGH
C_9 : 0.1μF
C_{11} : 0.01μF
R_1 : 10Ω, 1W
R_2 : 500Ω, 2W
R_3 : ~200Ω

L_1 : ϕ1.0 SILVER PLATED COPPER WIRE, 12ID, 4T, 20 LENGTH
L_2 : 10μH
L_3 : ϕ1.6 SILVER PLATED COPPER WIRE, 12ID, 2T, 8 LENGTH
L_4 : ϕ1.6 SILVER PLATED COPPER WIRE, 20ID, 3.5T, 22 LENGTH
L_5 : 10μH
D : 1S1555

P_o — P_i



IMD — P_o



SILICON NPN EPITAXIAL PLANAR TYPE

2SC1764

2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

FEATURES:

Specified 28V, 28MHz Characteristics

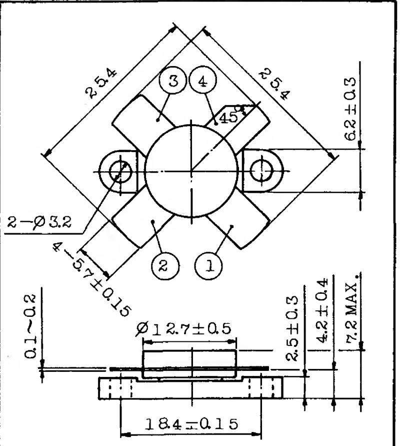
: Output Power : P_O=80W_{PEP}

: Minimum Gain : G_{pe}=14.5dB

: Efficiency : η_c=40%(Min.)

: Intermodulation Distortion : IMD=-30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−13B1A

Weight : 5.2g

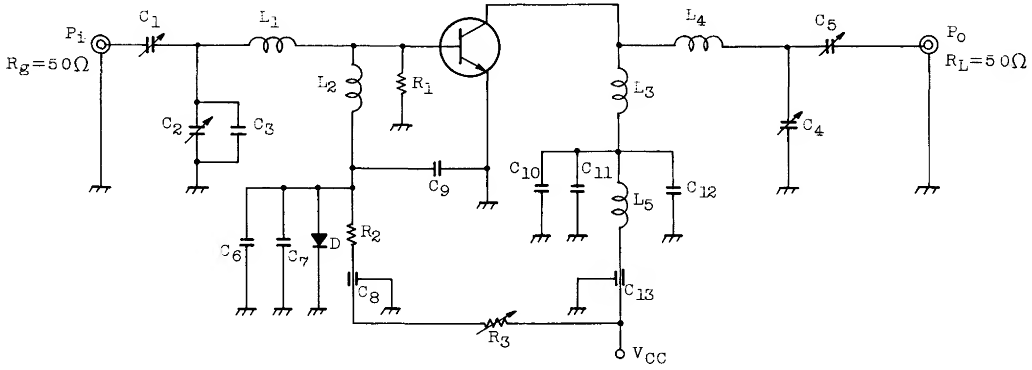
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	12	A
Collector Power Dissipation (Tc=25°C)	P_C	140	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	−65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

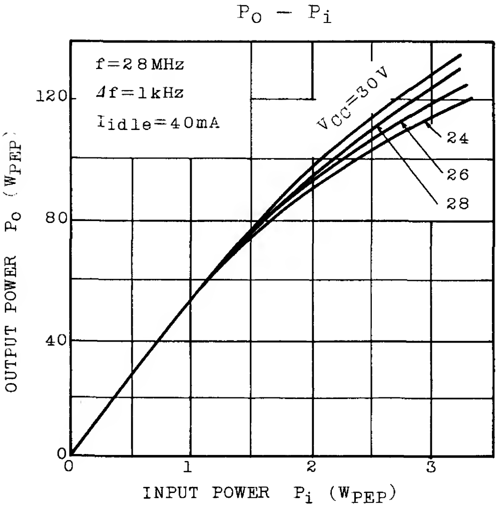
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	I_C=20mA, R_{EB}=10Ω	65	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=10A	10	-	-	
Transition Frequency	f_T	V_{CE}=15V, I_C=0.2A	50	-	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=28V, I_E=0, f=1MHz	-	220	300	pF
Power Gain	G_{pe}	V_{CC}=28V, f=28MHz 2-Tone, Δf=1kHz I_{idle}=40mA, P_O=80W_{PEP} (Fig.)	14.5	-	-	dB
Input Power	P_i		-	-	2.8	W_{PEP}
Collector Efficiency	η_c		40	-	-	%
Intermodulation Distortion	IMD		-	-	-30	dB

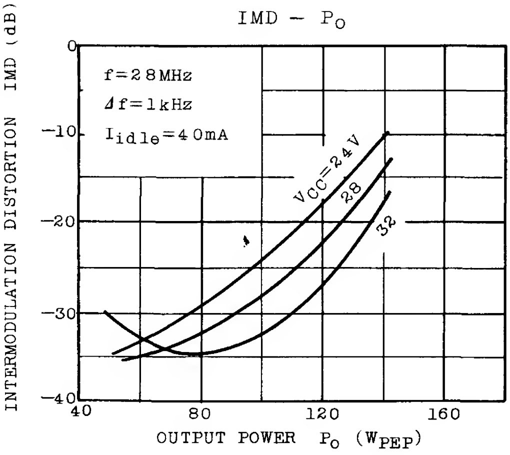
Fig. P_i TEST CIRCUIT



C1,C4,C5 : ~100pF
C2 : ~ 50pF
C3 : 100pF
C6,C10 : 0.1μF
C7,C12 : 22μF
C8,C13 : 6000pF FEED THROUGH
C9 : 0.1μF
C11 : 0.01μF
R1 : 10Ω, 1W
R2 : 500Ω, 2W
R3 : ~200Ω

L1 : ϕ1.0 SILVER PLATED COPPER WIRE, 12ID, 4T, 20 LENGTH
L2 : 10μH
L3 : ϕ1.6 SILVER PLATED COPPER WIRE, 12ID, 2T, 8 LENGTH
L4 : ϕ1.6 SILVER PLATED COPPER WIRE, 20ID, 3.5T, 22 LENGTH
L5 : 10μH
D : 1S1555





SILICON NPN EPITAXIAL PLANAR TYPE

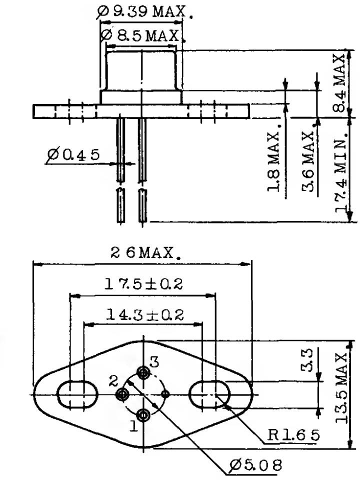
2SC1765

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=2.8W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=0.6W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=0.6W, f=470MHz

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	–
EIAJ	TC-17 , TB-22C
TOSHIBA	2-9A1B

Weight : 3.7g

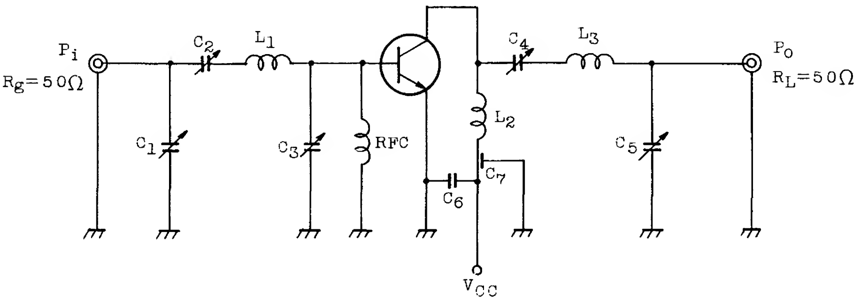
MAXIMUM RATINGS (T_a=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation (T_c=25 °C)	P_C	7.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

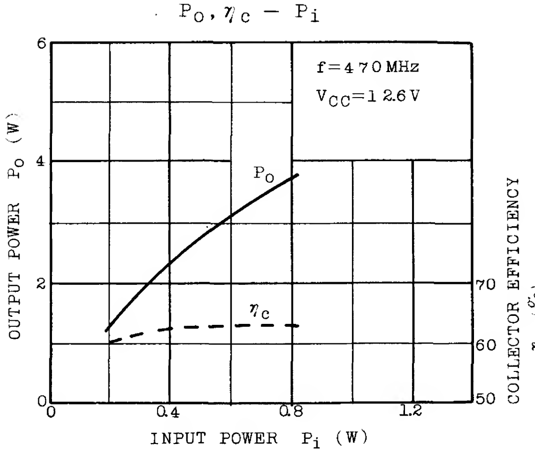
ELECTRICAL CHARACTERISTICS (T_a=25 °C)

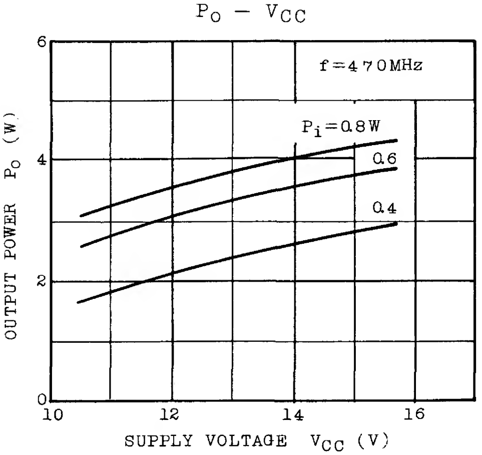
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	15	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=0.6W	2.8	3.2	-	W
Power Gain	G_{pe}		6.7	7.3	-	dB
Collector Efficiency	η_c		60	-	-	%

Fig. f=470MHz P_o TEST CIRCUIT



C_1,C_2,C_3 : ~10pF
C_4,C_5 : ~30pF
C6 : 0.02μF
C7 : 1000pF FEED THROUGH
L1 : ϕ1.6 SILVER PLATED COPPER WIRE, 7ID, ½T
L2 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 1½T
L3 : ϕ1.6 SILVER PLATED COPPER WIRE, 10ID, 1½T
RFC : ϕ0.7 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

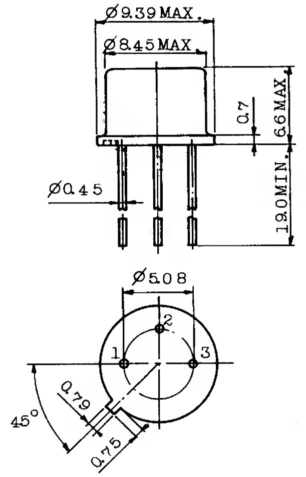
2SC1955

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES ·

- Output Power : P_O=2.8W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=0.15W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=13.5V, P_o=4W, f=175MHz

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1B

Weight : 1.2g

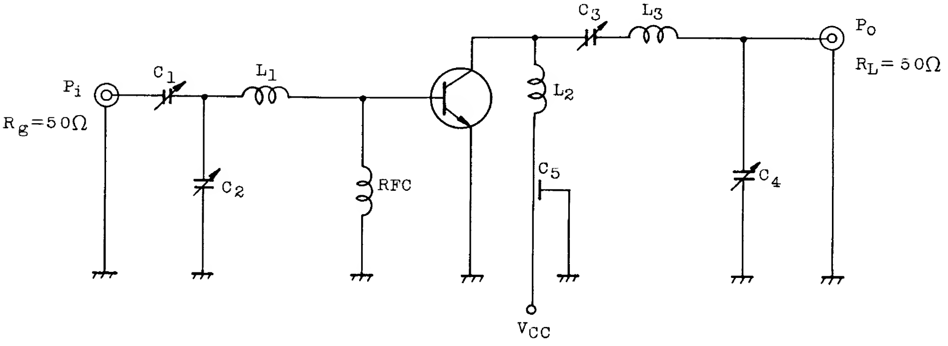
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	7.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Voltage	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	15	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=0.15W	2.8	3.2	-	W
Power Gain	G_{pe}		12.7	13.3	-	dB
Collector Efficiency	η_c		60	72	-	%

Fig. P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : ~30pF

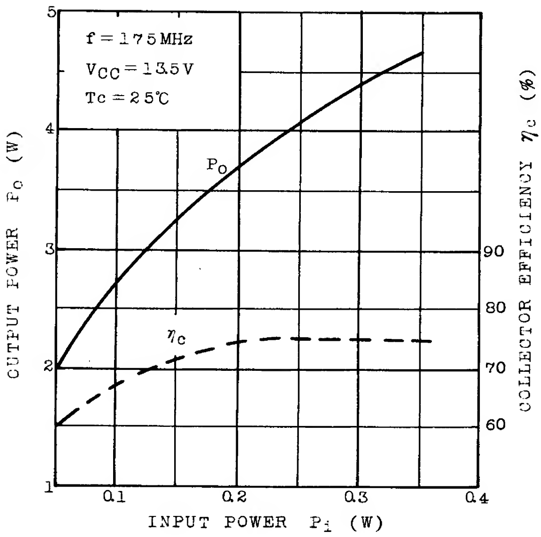
C_5 : 1000pF FEED THROUGH

L_1, L_2 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, IT

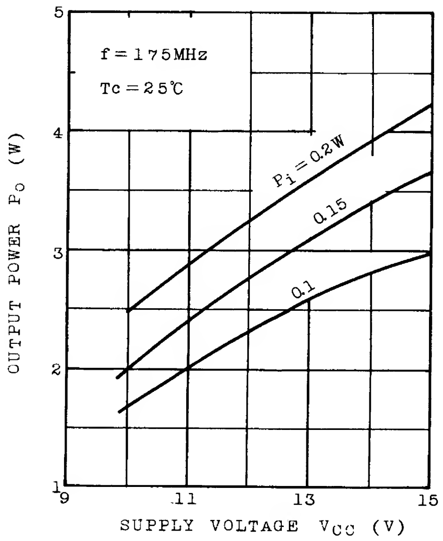
L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, $1\frac{3}{4}$T

RFC : 1μH CHOKE COIL

$P_o, \eta_c - P_i$



$P_o - V_{CC}$



SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

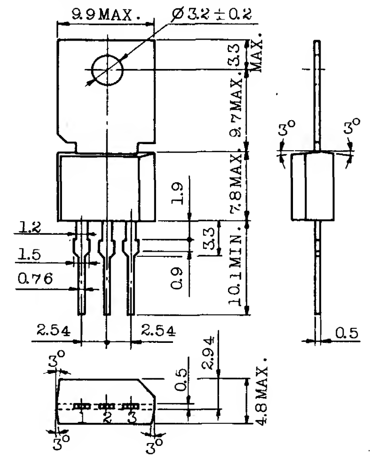
2SC2068

COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=300V
- Small Collector Output Capacitance : C_{ob}=4.0pF (Max.)

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER
(COLLECTOR CONNECTED TO TAB)

JEDEC	TO-202
EIAJ	—
TOSHIBA	2-10F1B

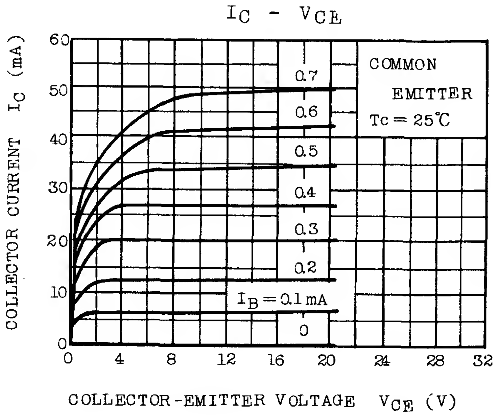
Weight :1.4g

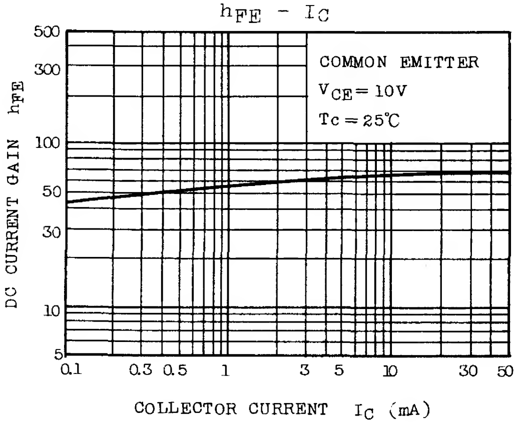
MAXIMUM RATINGS (Ta=25°C)

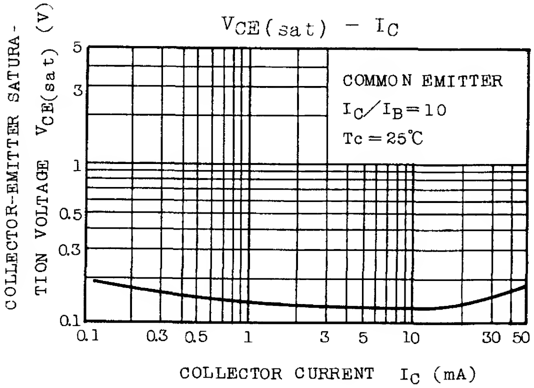
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	50	mA
Base Current	I_B	20	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55~150	°C

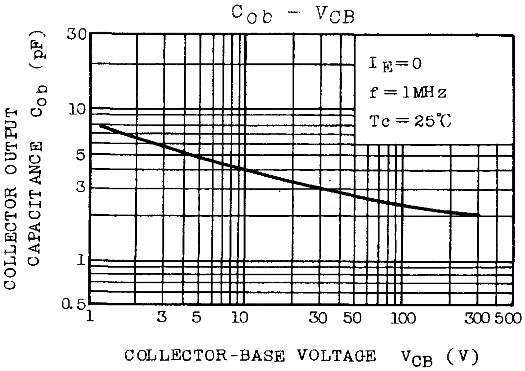
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=240V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
DC Current Gain	$h_{FE}(1)$	V_{CE}=10V, I_C=0.5mA	20	-	-	
	$h_{FE}(2)$	V_{CE}=10V, I_C=20mA	30	-	200	
Collecotr-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10mA, I_B=1mA	-	-	1.0	V
Transition Frequency	f_T	V_{CE}=20V, I_C=20mA	75	95	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=20V, I_E=0, f=1MHz	-	-	4.0	pF


I_C - V_{CE}
COMMON EMITTER
Tc = 25℃
0.7
0.6
0.5
0.4
0.3
0.2
I_B = 0.1 mA
0
COLLECTOR CURRENT I_C (mA)
0
10
20
30
40
50
60
0
4
8
12
16
20
24
28
32
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


h_{FE} - I_C
COMMON EMITTER
V_{CE} = 10V
Tc = 25℃
DC CURRENT GAIN h_{FE}
500
300
100
50
30
10
5
0.1
0.3
0.5
1
3
5
10
30
50
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)}$ - I_C
COMMON EMITTER
I_C/I_B = 10
Tc = 25℃
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
5
3
1
0.5
0.3
0.1
0.1
0.3
0.5
1
3
5
10
30
50
COLLECTOR CURRENT I_C (mA)


C_{ob} - V_{CB}
I_E = 0
f = 1MHz
Tc = 25℃
COLLECTOR OUTPUT CAPACITANCE C_{ob} (pF)
30
10
5
3
1
0.5
1
3
5
10
30
50
100
300
500
COLLECTOR-BASE VOLTAGE V_{CB} (V)

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

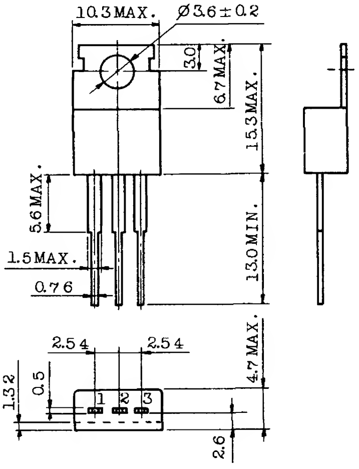
2SC2073

POWER AMPLIFIER APPLICATIONS.
VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- Wide Safe Operating Area.
- Complementary to 2SA940

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Weight : 1.9g

Mounting kit No. AC75

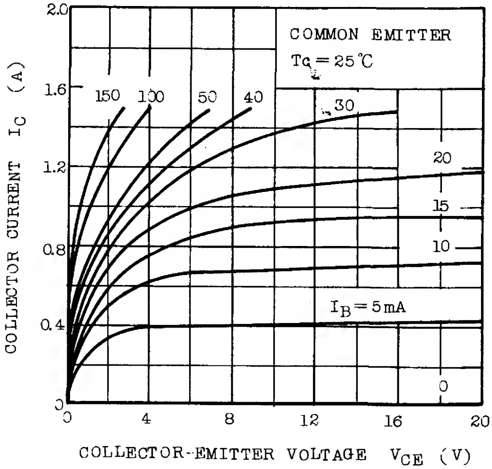
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	150	V
Collector-Emitter Voltage		V_{CEO}	150	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

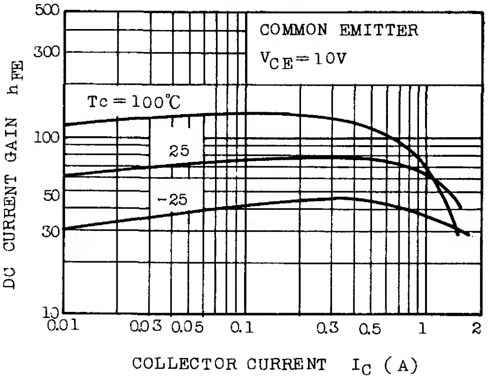
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=120V, I_E=0	−	−	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	−	−	10	μA
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=500mA	40	75	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	−	−	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=10V, I_C=500mA	0.65	0.75	0.85	V
Transition Frequency	f_T	V_{CE}=10V, I_C=500mA	−	4	−	MHz
Collector Output Capacitance	Cob	V_{CB}=10V, I_E=0, f=1MHz	−	35	−	pF

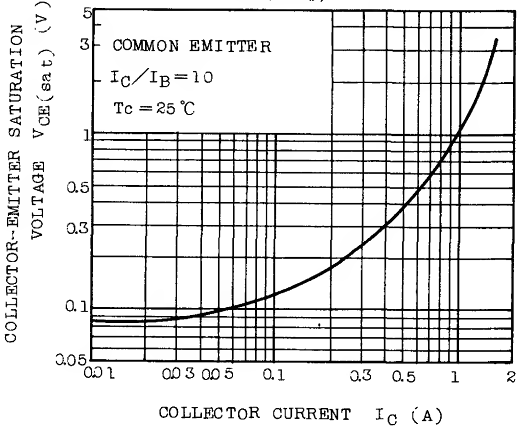
I_C - V_{CE}



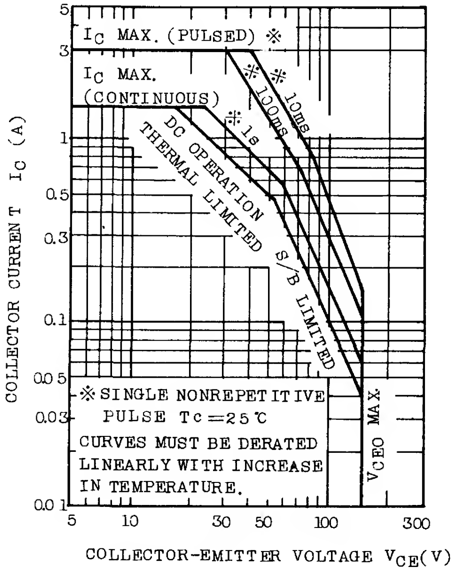
h_{FE} - I_C



$V_{CE(sat)}$ - I_C



SAFE OPERATING AREA



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

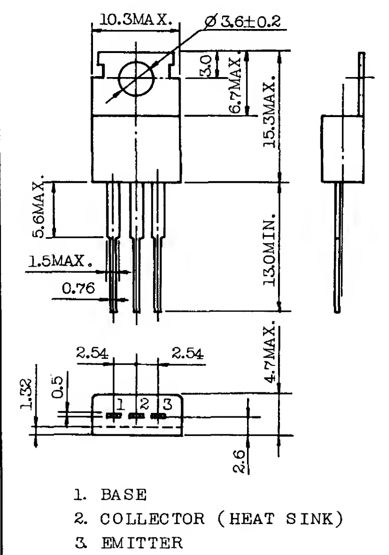
2SC2075

27MHz POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Recommended for Output Stage Application of AM 4W Transmitter.
- High Power Gain.
- Wide Area of Safe Operation.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10 A 1 A

Mounting Kit No. AC75
Weight : 1.9g

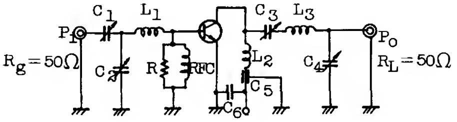
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage $R_{BE}=50\Omega$	V_{CER}	80	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	Tj	150	°C
Storage Temperature Range	Tstg	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

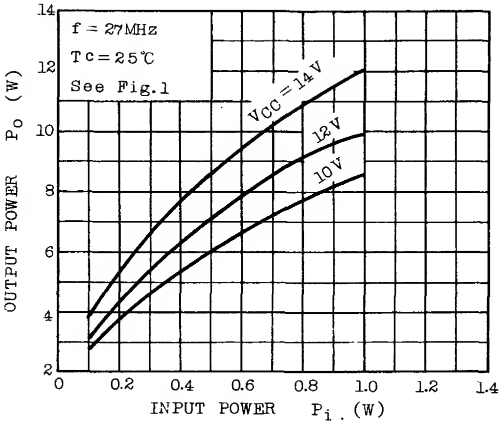
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V,\ I_E=0$	-	-	10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CER}$	$I_C=10mA,\ R_{BE}=50\Omega$	80	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	$I_E=1.0mA,\ I_C=0$	4.0	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V,\ I_C=0.5A$	25	-	-	
		$h_{FE(2)}$	$V_{CE}=2V,\ I_C=3A$	15	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A,\ I_B=0.3A$	-	-	1.5	V
Transition Frequency		f_T	$V_{CE}=5V,\ I_C=500mA$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	40	-	pF
Output Power (Fig. 1)		P_o	$V_{CC}=12V, Pi=0.3W, f=27MHz$	3.5	-	-	W

Fig. 1 P_o TEST CIRCUIT

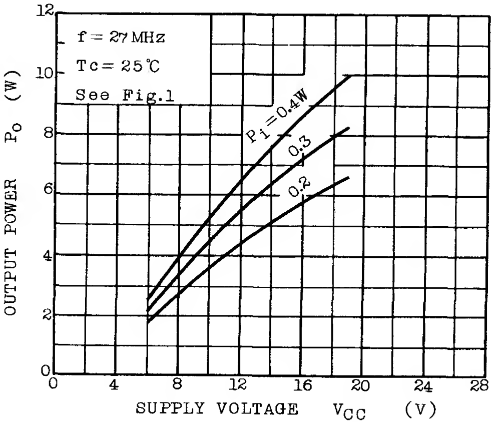


C_1 : ~100pF, C_2, C_3 : ~150pF, C_4 : ~300pF, C_5 : 1000pF
C_6 : 0.01μF R : 250Ω
L_1 : 0.8mmØ UEW, 7T, 8mm I.D L_2 : 0.8mmØ UEW, 5T, 8mm I.D
L_3 : 0.8mmØ UEW, 10T, 8mm I.D RFC : 0.35mmØ UEW, 17T, 5mm I.D

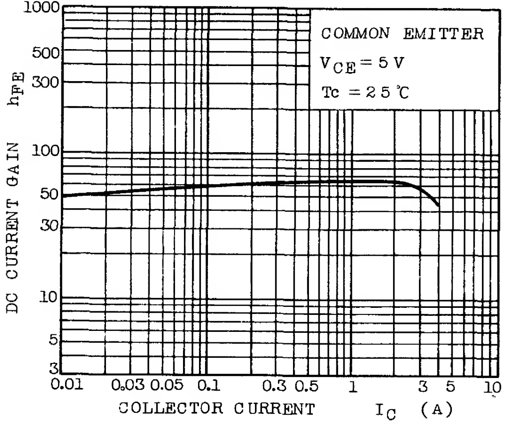
P_O − P_i



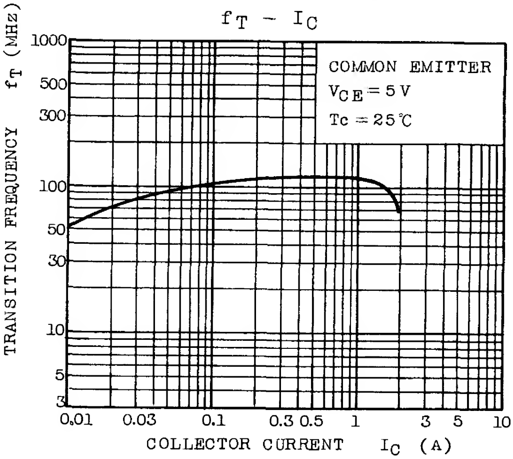
P_O − V_{CC}



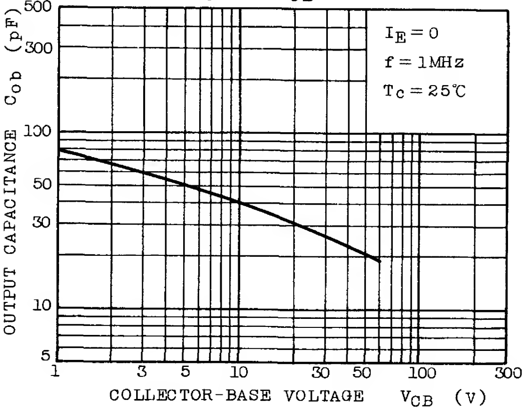
h_{FE} − I_C



f_T − I_C



C_{ob} − V_{CB}



P_C − Ta

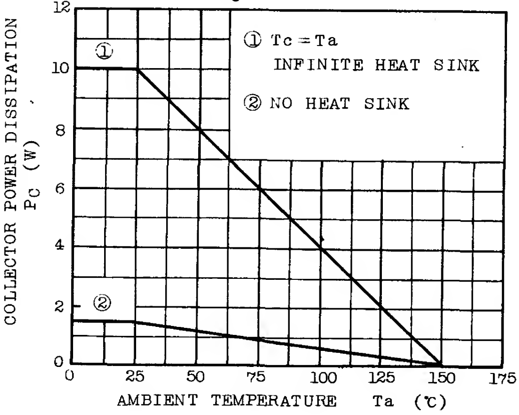
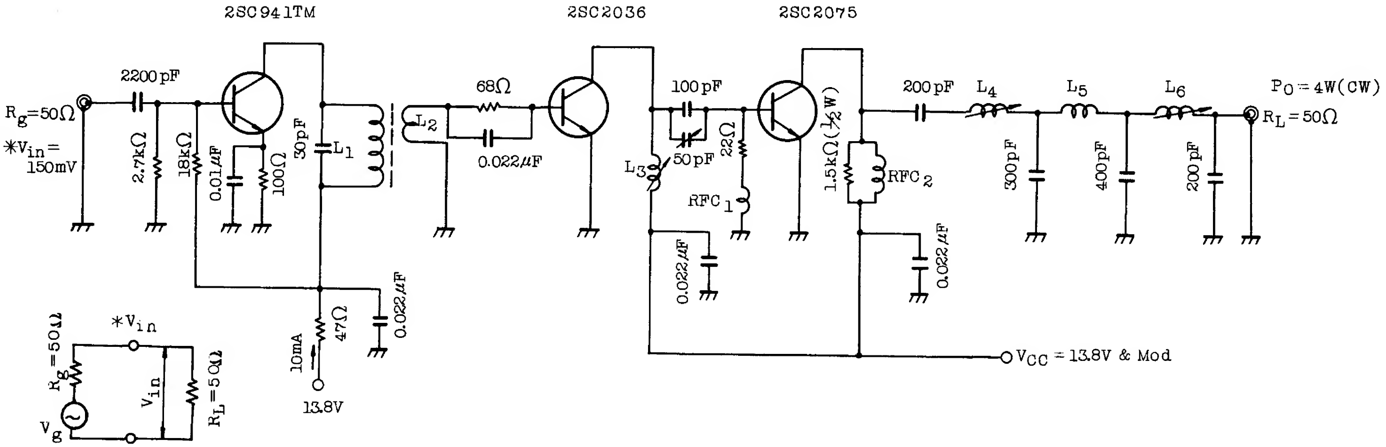


Fig.2 27MHz 4W OUTPUT AM TRANSCEIVER CIRCUIT



L1 : 4mmØ BOBBIN WITH FERRITE CORE , 0.08mmØ UEW, 8 TURNS

L2 : 4mmØ BOBBIN WITH FERRITE CORE , 0.08mmØ UEW, 2 TURNS

L3, L6 : 6.5mmØ BOBBIN WITH FERRITE CORE , 0.6mmØ Sn PLATED COPPER WIRE 6½ TURNS

L4 : 6.5mmØ BOBBIN WITH FERRITE CORE , 0.6mmØ Sn PLATED COPPER WIRE 8½ TURNS

L5 : 0.6mmØ Sn PLATED COPPER WIRE , 6.5mm I.D, 8½ TURNS

RFC1 : 47μH, 7BA−480k (TOKO)

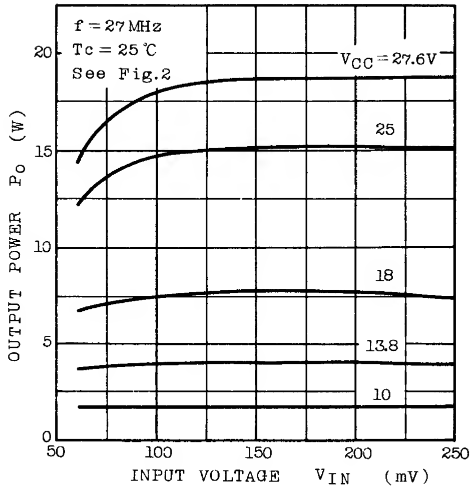
RFC2 : 0.2mmØ UEW, 30 TURNS

RESISTER : ¼W CARBON

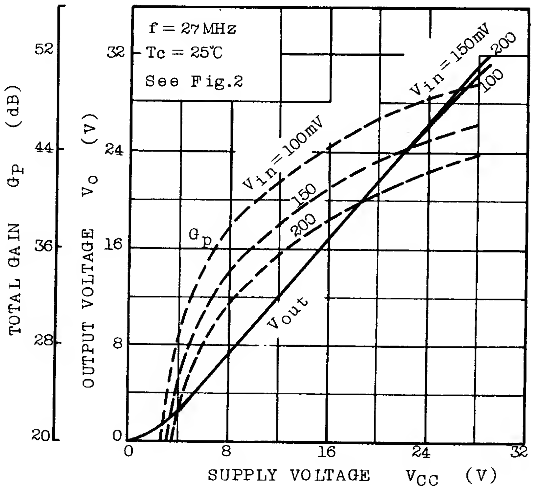
CAPACITER : CERAMIC

APPLICATION CIRCUIT CHARACTERISTIC

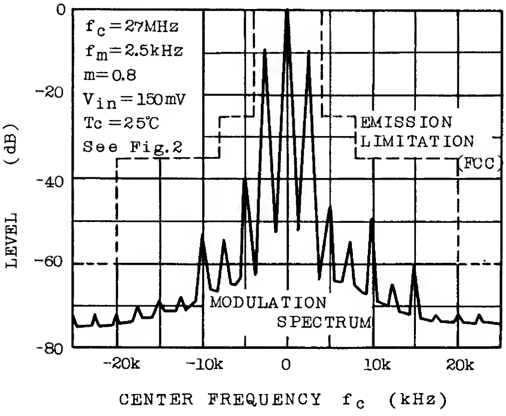
$P_O - V_{IN}$



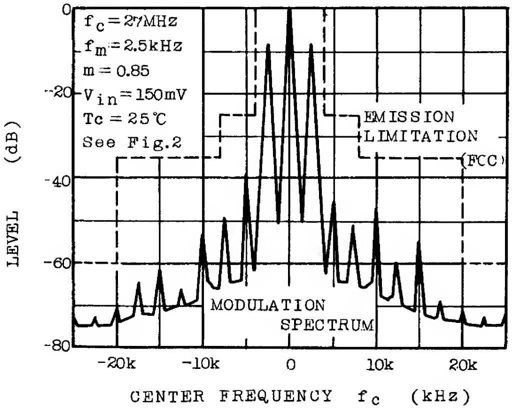
V_O, $G_P - V_{CC}$



80% MODULATION SPECTRUM EMISSION LIMITATION (FCC)



85% MODULATION SPECTRUM EMISSION LIMITATION (FCC)



SILICON NPN EPITAXIAL PLANAR TYPE

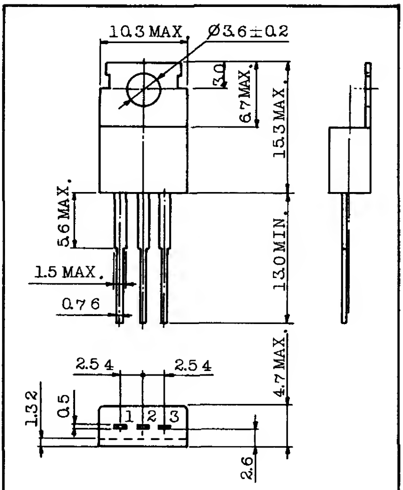
2SC2098

CITIZEN BAND AND HAM BAND UP TO 50MHz RF
POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES:

- Recommended for 12W(PEP) SSB Citizen Band Transceiver Applications.
- High Power Gain : G_{pe}=11.8dB(Typ.) @ f=28MHz
- Designed to Withstand Load Mismatch at All Phase Angles with Infinite VSWR at 17 Volts.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Weight : 1.9g

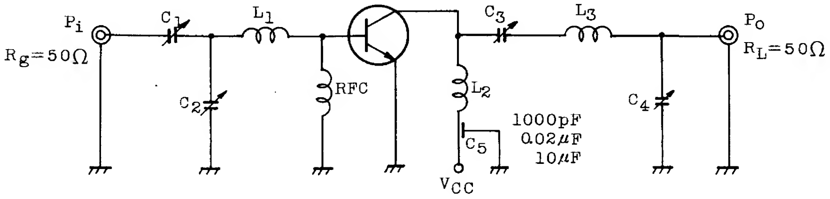
MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	V
Collector-Emitter Voltage (R_{EB}=10Ω)	V_{CER}	70	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (Tc=25 °C)	P_C	20	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

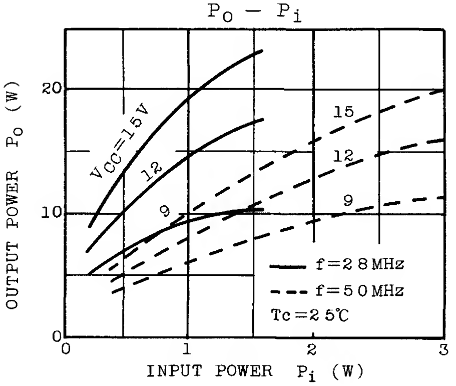
ELECTRICAL CHARACTERISTICS (Ta=25°C)

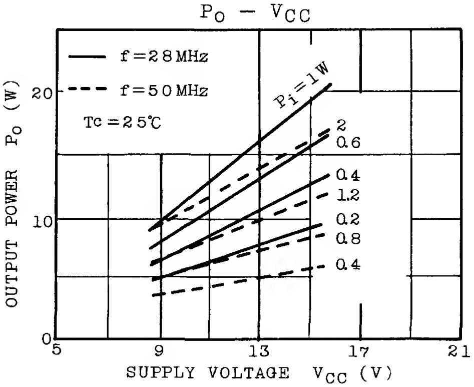
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=40V, I_E=0	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	70	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	I_C=10mA, R_{EB}=10Ω	70	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=4A	20	-	100	
Collector-Emitter Satulation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	100	-	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	80	120	pF
Output Power	$P_o(1)$	V_{CC}=12V, f=28MHz P_i=1W, $\eta_c \geq$60% (Fig.)	13	15	-	W
	$P_o(2)$	V_{CC}=12V, f=50MHz P_i=3W, $\eta_c \geq$60% (Fig.)	-	16	-	W

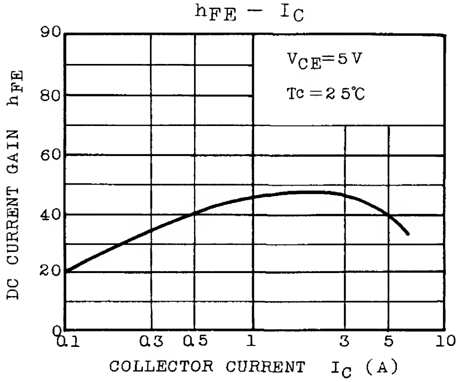
Fig. P_O TEST CIRCUIT



		28MHz	50MHz
C1 :		~100pF	~ 50pF
C2,C3 :		~150pF	~100pF
C4 :		~300pF	~200pF
L1 :	ϕ0.8 SILVER PLATED COPPER WIRE,	10ID, 8T	10ID, 5T
L2 :	ϕ0.8 SILVER PLATED COPPER WIRE,	10ID, 5T	8ID, 5T
L3 :	ϕ0.8 SILVER PLATED COPPER WIRE,	10ID, 8T	10ID, 7T


$P_O - P_i$


$P_O - V_{CC}$


$h_{FE} - I_C$

SILICON NPN EPITAXIAL PLANAR TYPE

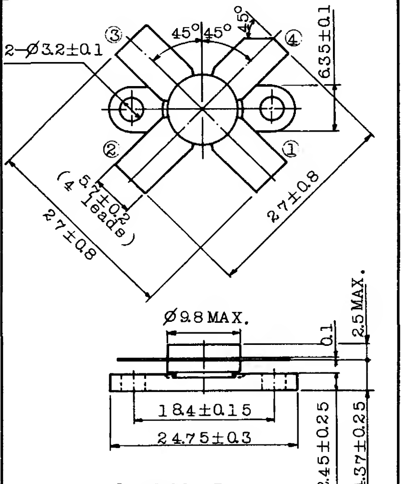
2SC2099

2～30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES :

. Specified 12.5V, 28MHz Characteristics
- : Output Power : P_O=20W_{PEP}
- : Minimum Gain : Gpe=12dB
- : Efficiency : η_C=35%(Min.)
- : Intermodulation Distortion : IMD=-30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2-10H1A

Weight : 40g

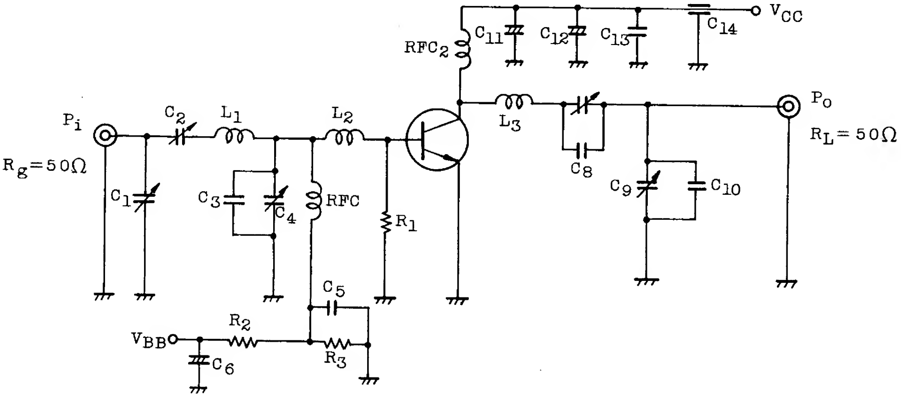
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	60	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

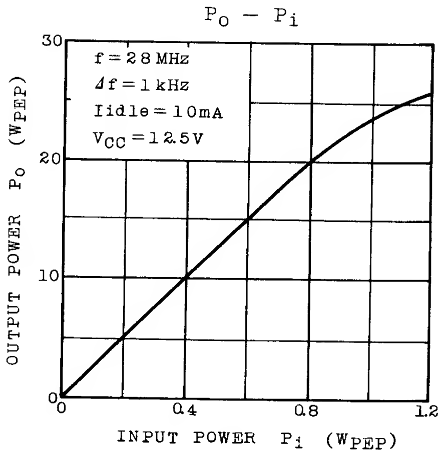
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=50mA, V_{EB}=0	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	20	-	-	
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=12.5V, I_E=0, f=1MHz	-	-	250	pF
Power Gain	G_{Pe}	V_{CC}=12.5V, f=28MHz 2-Tone, Δf=1kHz I_{idle}=10mA, P_O= 20W_{PEP} (Fig.)	12.0	-	-	dB
Input Power	P_i		-	-	1.2	W_{PEP}
Collector Efficiency	η_C		35	45	-	%
Intermodulation Distortion	IMD		-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=28MHz, Δf=1kHz, P_O=20W_{PEP}	-	1.1 -j0.25	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.0 -j0.75	-	Ω

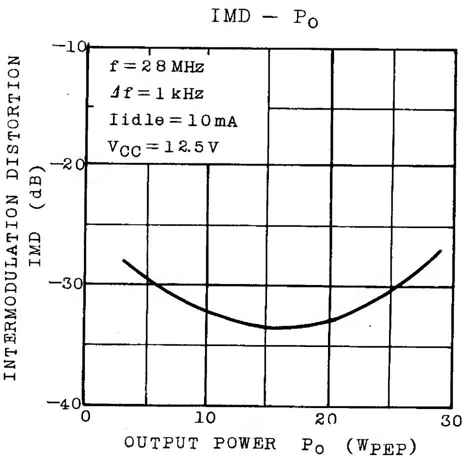
Fig. P_i TEST CIRCUIT



C_1, C_2, C_4, C_7 : 7 ~ 150pF
C_9 : 10 ~ 200pF
C_3 : 250pF
C_5, C_{13} : 0.4μF
C_6 : 100μF 10WV
C_8 : 150pF
C_{10} : 600pF
C_{11}, C_{12} : 22μF 35WV
C_{14} : 1000pF (FEED THROUGH)

L_1 ; ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 9ID, 2T
L_3 : ϕ1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T
RFC_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T
RFC_2 : ϕ1.5 ENAMEL COATED COPPER WIRE, 12ID, 15T
R_1 : 5.6Ω (1/2W)
R_2 : 5Ω (5W)
R_3 : 1.5Ω (10W)





SILICON NPN EPITAXIAL PLANAR TYPE

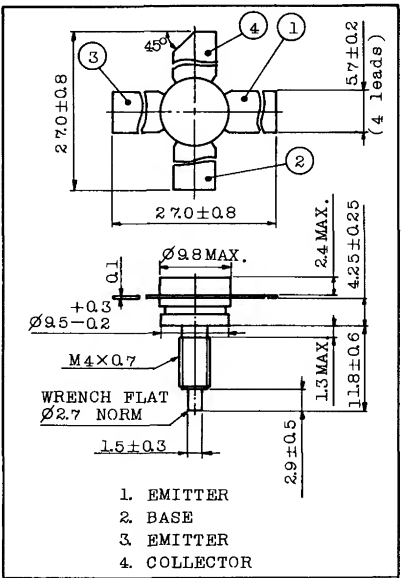
2SC2101

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=6W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=0.5W)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2—10G1A

Mounting Kit No. AC57
Weight : 3.3g

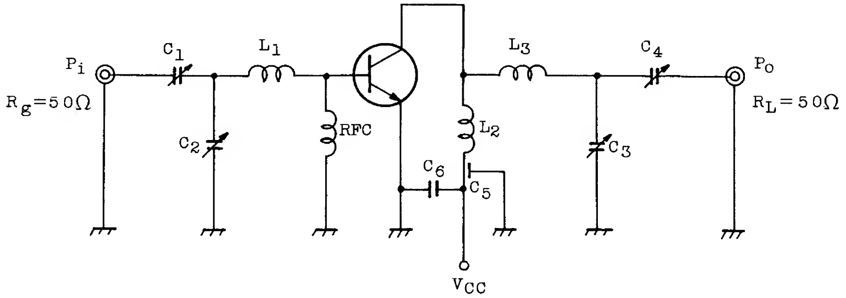
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

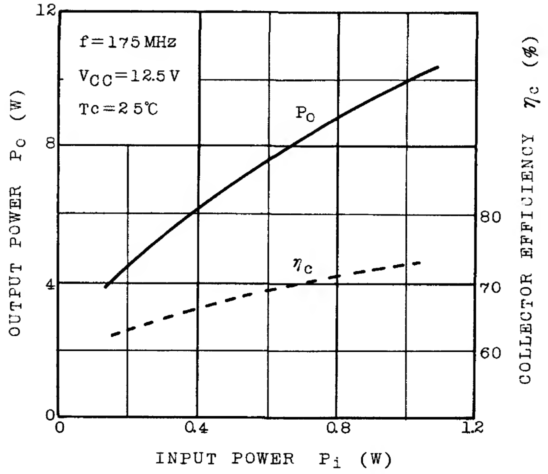
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	25	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz P_i=0.5W	6	7	-	W
Power Gain	G_{pe}		10.7	11.5	-	dB
Collector Efficiency	η_c		60	68	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz P_o=6W	-	1.1 -j0.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.4 -j10	-	Ω

Fig. P_o TEST CIRCUIT

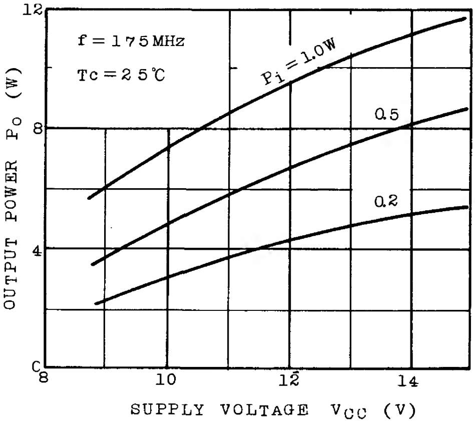


C_1 : 3 ~ 12pF
C_2 : 5 ~ 20pF
C_3, C_4 : 3.5 ~ 30pF
C_5 : 1000pF FEED THROUGH
C_6 : 0.01μF CERAMIC CONDENSER
L_1, L_2 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 2T
L_3 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 1T
RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 8T

P_o, η_c − P_i



P_o − V_{CC}



SILICON NPN EPITAXIAL PLANAR TYPE

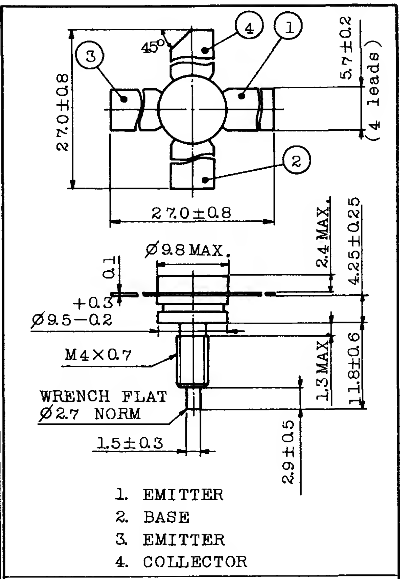
2SC2102

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_o=15W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=1.3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30;1 VSWR @ V_{CC}=15V, P_i=1.3W, f=175MHz

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2—10G1A

Mounting Kit No. AC57
Weight : 3.3g

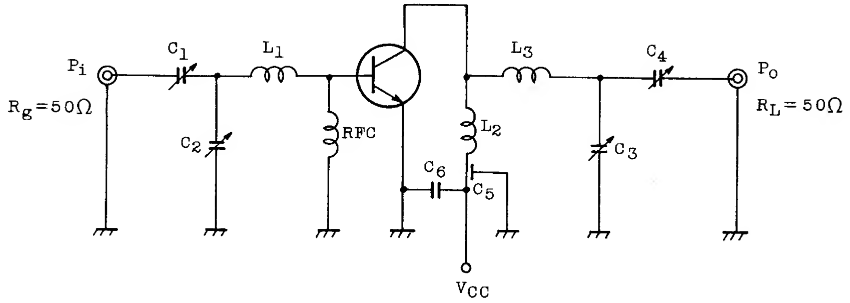
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	35	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.)	15	18	-	W
Power Gain	G_{pe}	V_{CC}=12.5V, f=175MHz	10.6	11.4	-	dB
Collector Efficiency	η_c	P_i=1.3W	60	72	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=15W	-	0.8 +j0.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.6 -j1.9	-	Ω

Fig. P_o TEST CIRCUIT



C_1 : 5 ~ 20pF

C_2,C_3,C_4 : 3.5 ~ 30pF

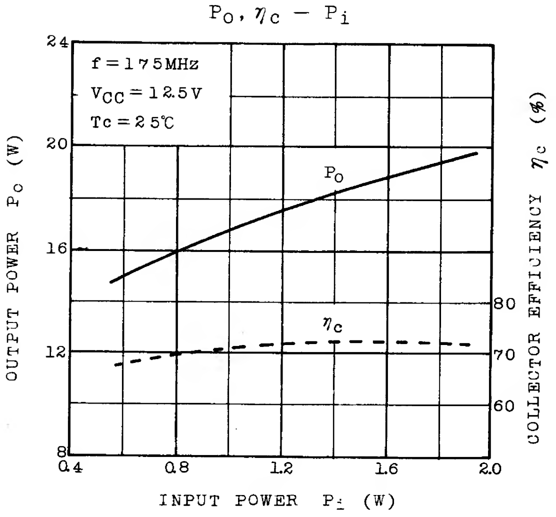
C_5 : 1000pF FEED THROUGH

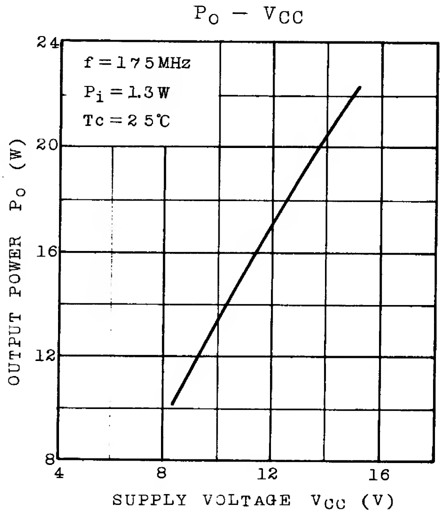
C_6 : 0.01μF CERAMIC CONDENSER

L_1,L_3 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 1T

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 2T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 3T





SILICON NPN EPITAXIAL PLANAR TYPE

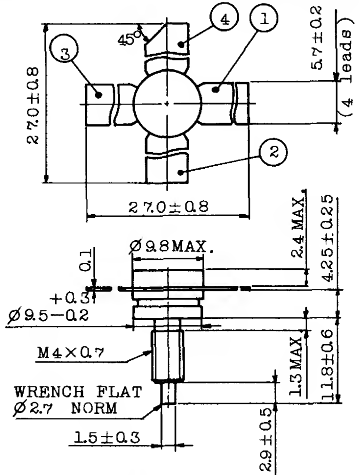
2SC2103A

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=27W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=4.2W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=14.5V, P_i=4W, f=175MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Mounting Kit No. AC57
Weight : 3.3g

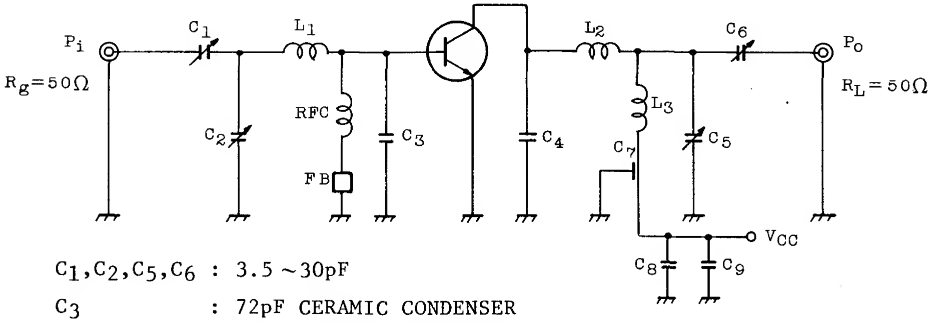
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	6.0	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

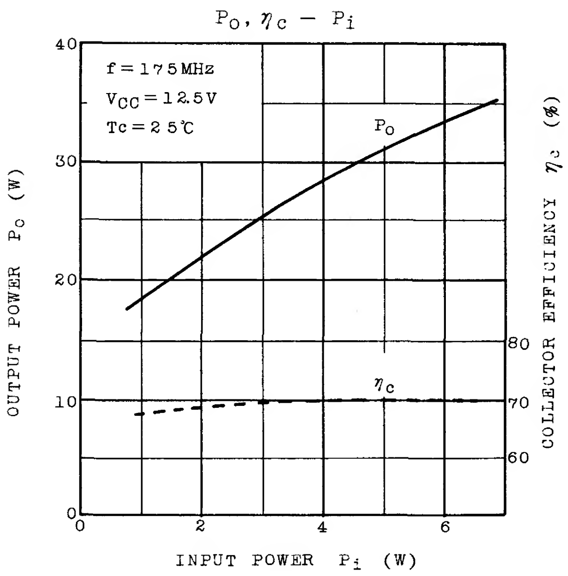
ELECTRICAL CHARACTERISTICS (Ta=25°C)

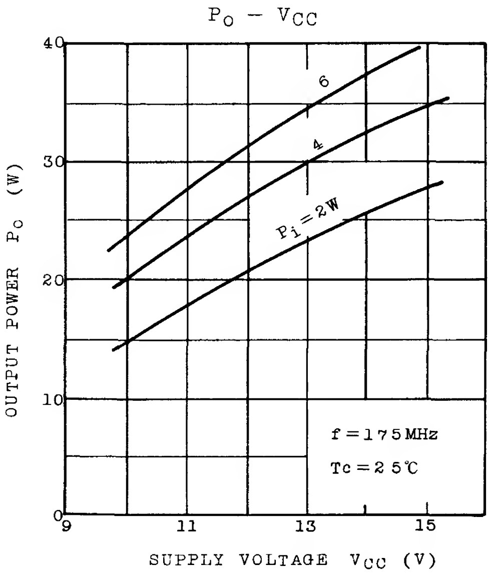
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4.0	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=3A	10	-	150	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=4.2W	27	29	-	W
Power Gain	G_{pe}		8.0	8.4	-	dB
Collector Efficiency	η_c		60	70	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=27W	-	0.75 +j2.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.4 +j3.4	-	Ω

Fig. P_O TEST CIRCUIT



C_1, C_2, C_5, C_6 : 3.5 ~30pF
C_3 : 72pF CERAMIC CONDENSER
C_4 : 47pF CERAMIC CONDENSER
C_7 : 1000pF FEED THROUGH
C_8 : 0.01μF CERAMIC CONDENSER
C_9 : 10μF CERAMIC CONDENSER
L_1, L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 1T
L_3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T
RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 10T
FB : FERRITE BEADS





SILICON NPN EPITAXIAL PLANAR TYPE

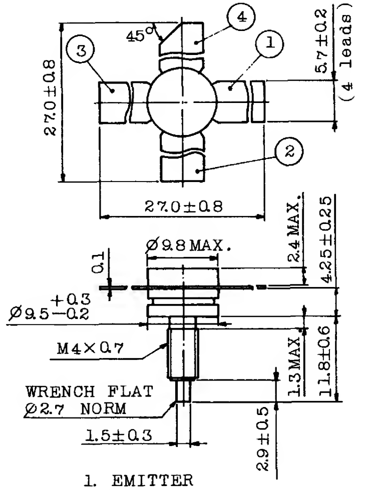
2SC2104

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=3W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=0.4W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=15V, P_i=0.4W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Weight : 3.3g
Mounting Kit No. AC57

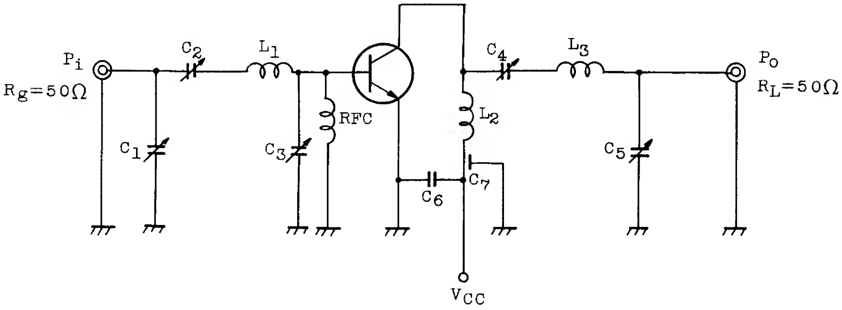
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation (T_c=25°C)	P_C	7.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

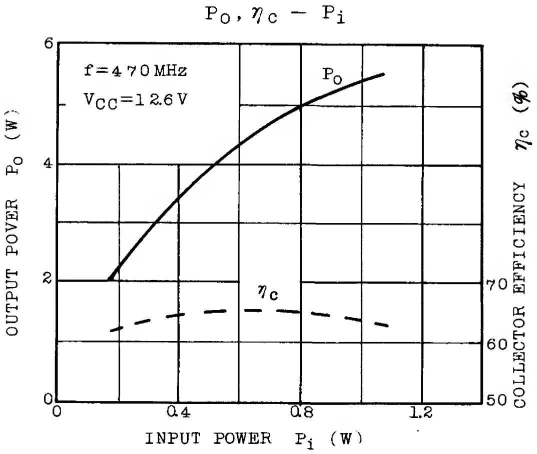
ELECTRICAL CHARACTERISTICS (T_a=25°C)

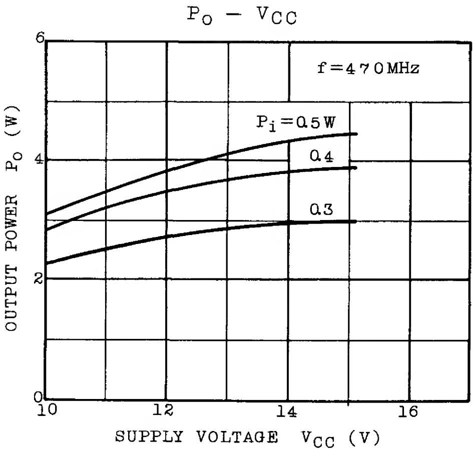
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	20	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=0.4W	3	-	-	W
Power Gain	G_{pe}		8.7	-	-	dB
Collector Efficiency	η_c		50	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=3W	-	1.5+j3	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	17.5−j8.5	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C1,C2,C3 : ~10pF
C4,C5 : ~30pF
C6 : 0.02μF
C7 : 1000pF FEED THROUGH
L1 : ϕ1.6 SILVER PLATED COPPER WIRE, 7ID, ½T
L2 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 1½T
L3 : ϕ1.6 SILVER PLATED COPPER WIRE, 10ID, ½T
RFC : ϕ0.7 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

2SC2105

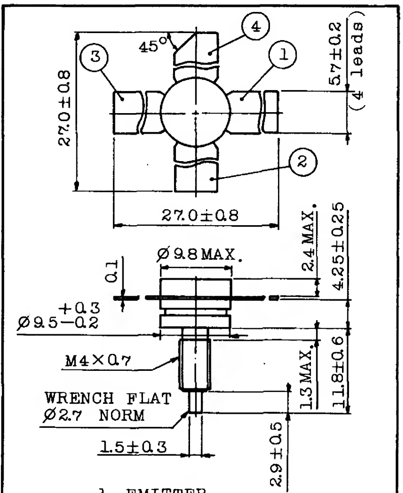
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

. Output Power : P_o=6W(Min.)
(f=470MHz, V_{CC}=12.6V, P_i=1W)

. 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_o=6.5W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Weight : 3.3g
Mounting Kit No. AC57

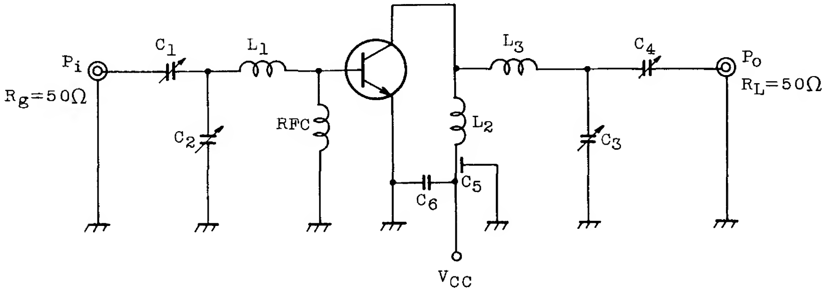
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	25	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=1W	6	-	-	W
Power Gain	G_{pe}		7.7	-	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=6W	-	1.4+j3.8	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	11.3−j2.5	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1,C_3 : 1.5 ~5pF

C_2,C_4 : 2 ~15pF

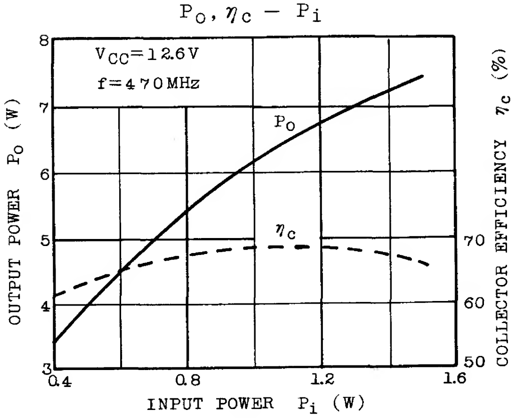
C_5 : 1000pF FEEED THROUGH

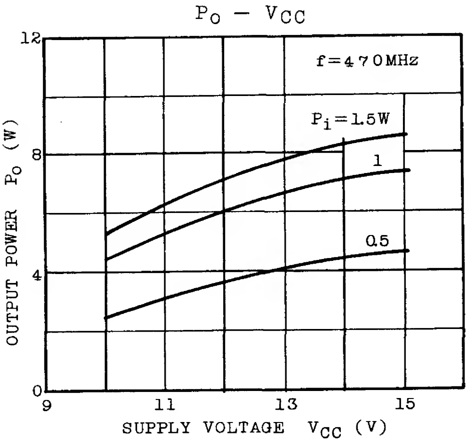
C_6 : 0.01μF

L1,L3 : 5mm × 15mm COPPER PLATE

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

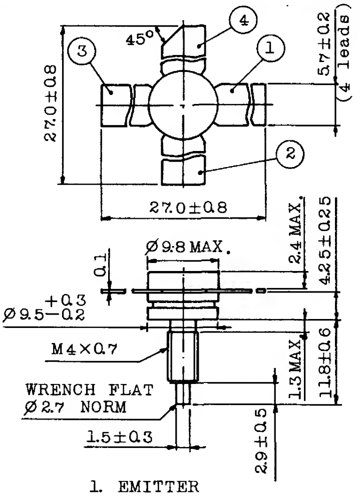
2SC2106

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_o=12W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=15V, P_i=3W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Weight : 3.3g
Mounting Kit No. AC57

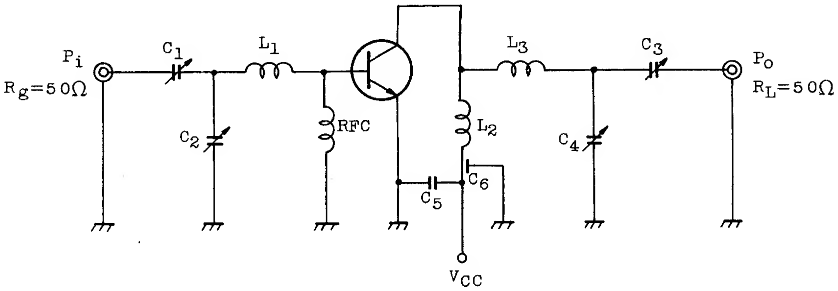
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	165 ~175	°C

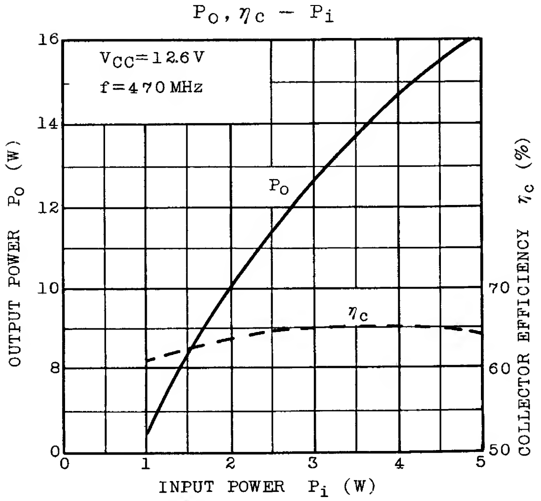
ELECTRICAL CHARACTERISTICS (Ta=25°C)

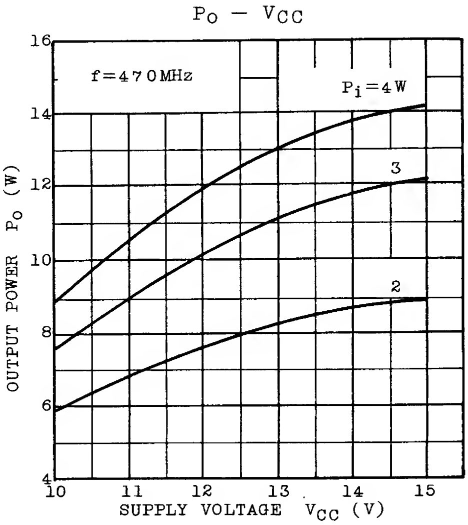
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1.5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	45	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=3W	12	-	-	W
Power Gain	G_{pe}		6	-	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=12W	-	0.9+ j3.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.3-j1	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C1,C4 : 1.5～5pF
C2,C3 : 2～15pF
C5 : 0.01μF
C6 : 1000pF FEED THROUGH
L1,L3 : 5mm×15mm COPPER PLATE
L2 : φ1 SILVER PLATED COPPER WIRE, 10ID, ½T
RFC : φ1 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

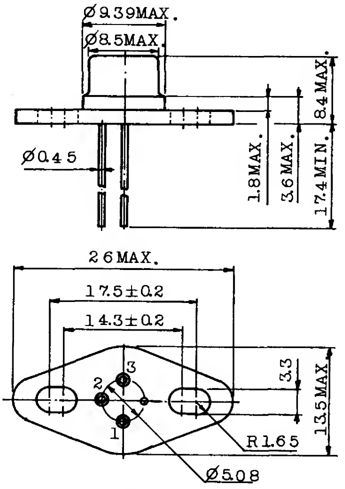
2SC2117

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=2.8W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=0.15W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=13.5V, P_O=4W, f=175MHz

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−9A1B

Weight : 3.7g

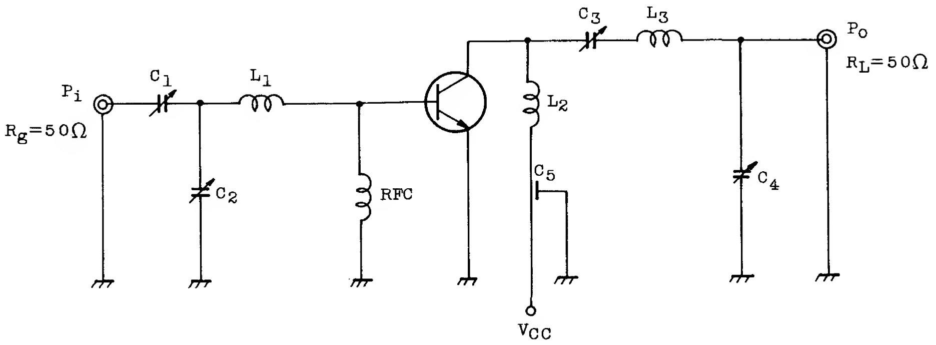
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation (Tc=25 °C)	P_C	7.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	15	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz P_i=0.15W	2.8	3.2	-	W
Power Gain	G_{pe}		12.7	13.3	-	dB
Collector Efficiency	η_c		60	72	-	%

Fig. P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : ~30pF

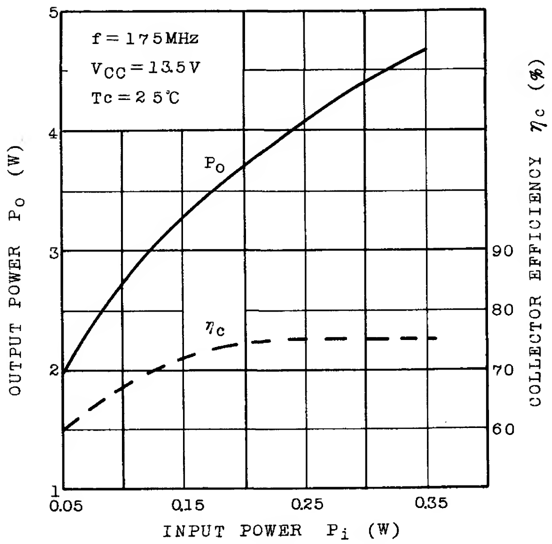
C_5 : 1000pF FEED THROUGH

L_1, L_2 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T

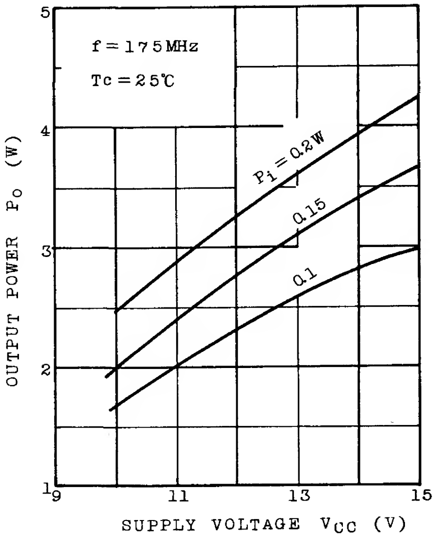
L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, $1\frac{3}{4}$T

RFC : 1μH CHOKE COIL

$P_o, \eta_c - P_i$



$P_o - V_{CC}$

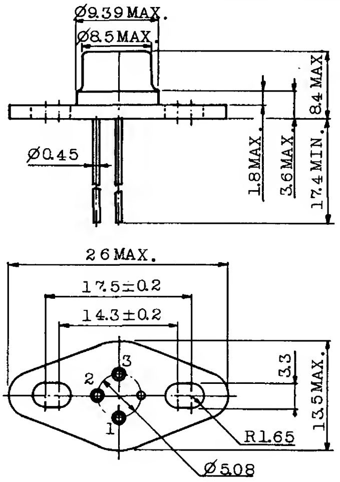


SILICON NPN EPITAXIAL PLANAR TYPE

2SC2118

VHF BAND POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. EMITTER (CASE)
2. BASE
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−9A1B

Weight : 3.7g

FEATURES :

- Output Power : P_O=5W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=0.6W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=15V, P_i=0.6W, f=175MHz

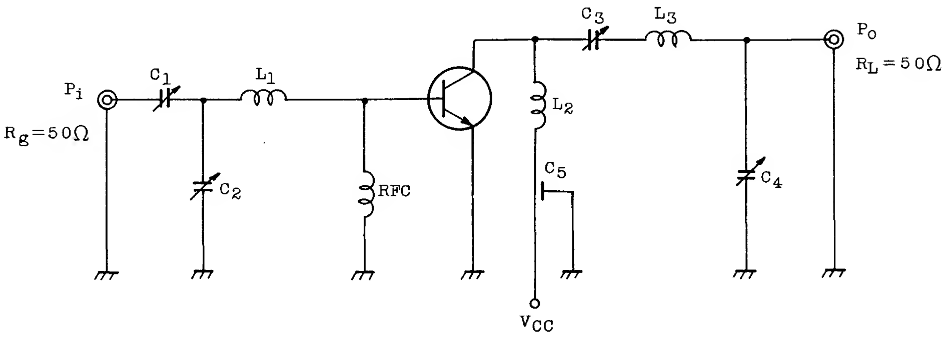
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	13	25	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=0.6W	5.0	6.0	-	W
Power Gain	G_{pe}		9.2	10	-	dB
Collector Efficiency	η_c		60	76	-	%

Fig. P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : ~30pF

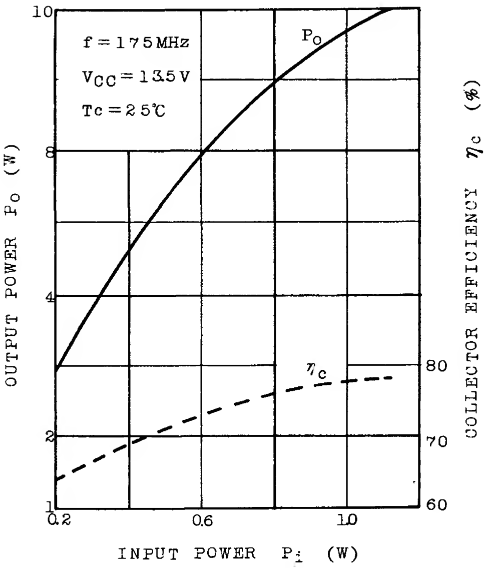
C_5 : 1000pF FEED THROUGH

L_1, L_2 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T

L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 8ID, 7/4T

RFC : 1μH CHOKE COIL

P_o, η_c − P_i



SILICON NPN EPITAXIAL PLANAR TYPE

2SC2173

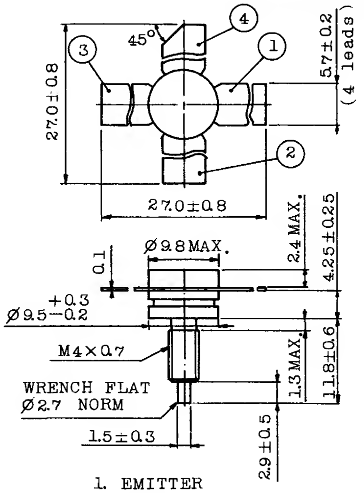
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

. Output Power : P_O=25W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=10W)

. 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=10W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Mounting Kit No. AC57
Weight : 3.3g

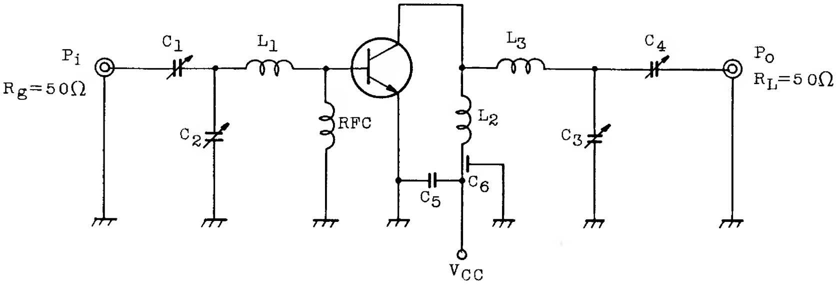
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

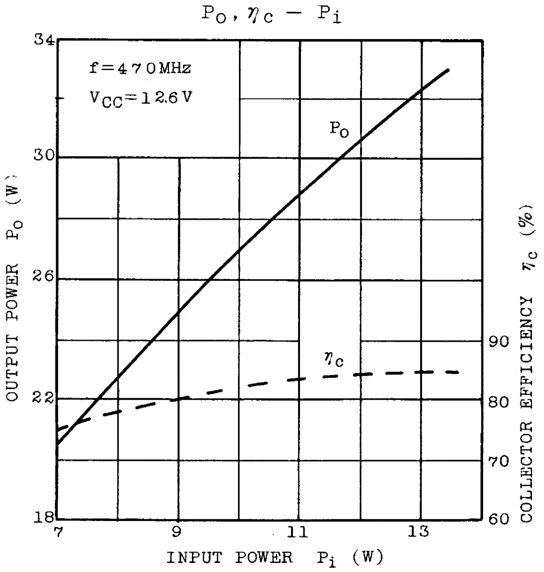
ELECTRICAL CHARACTERISTICS (Ta=25 °C)

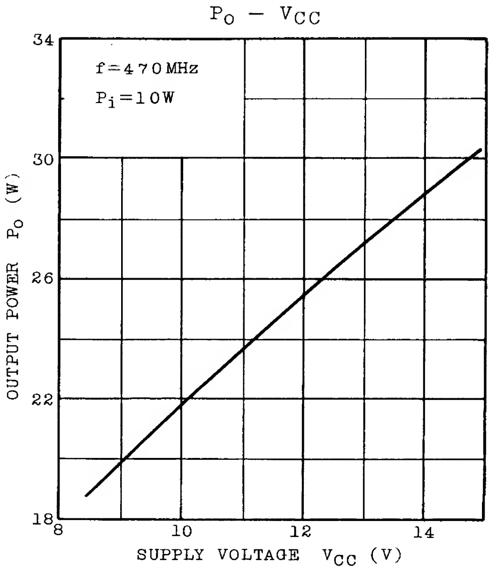
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=3A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=10W	25	28	-	W
Power Gain	G_{pe}		3.9	4.5	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=25W	-	1.1+ j2.6	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.7+ j0.8	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1, C_3 : 1.5 ~ 5pF
C_2, C_4 : 2.2~15pF
C_5 : 0.01μF
C_6 : 1000pF FEED THROUGH
L_1, L_3 : 5mm×15mm COPPER PLATE
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, ½T
RFC : ϕ1 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

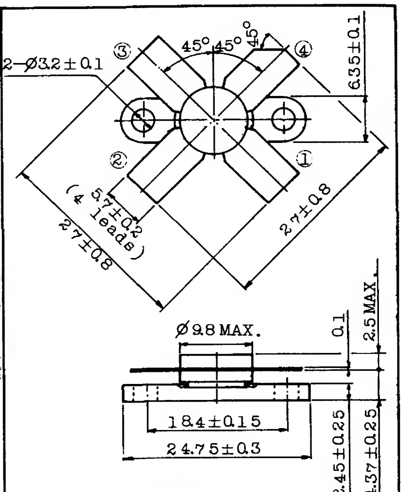
2SC2178

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=15W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=1.3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=15V, P_i=1.3W, f=175MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2—10H1A

Weight : 4.0g

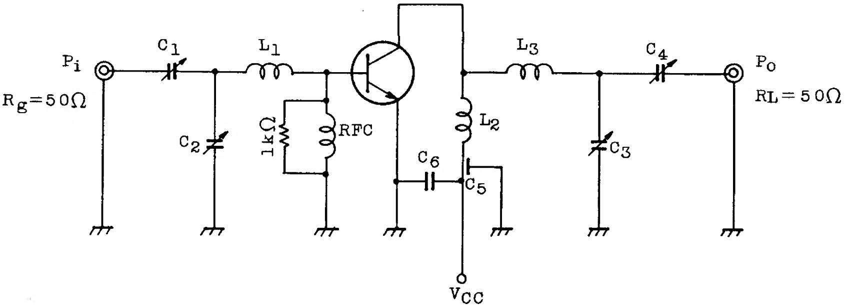
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	35	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=1.3W	15	18	-	W
Power Gain	G_{pe}		10.6	11.4	-	dB
Collector Efficiency	η_c		60	72	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=15W	-	1.25 +j0.6	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		—	4.9 -j3.0	-	Ω

Fig. P_o TEST CIRCUIT



C_1 : ~20pF

C_2,C_3,C_4 : ~30pF

C_5 : 1000pF FEED THROUGH

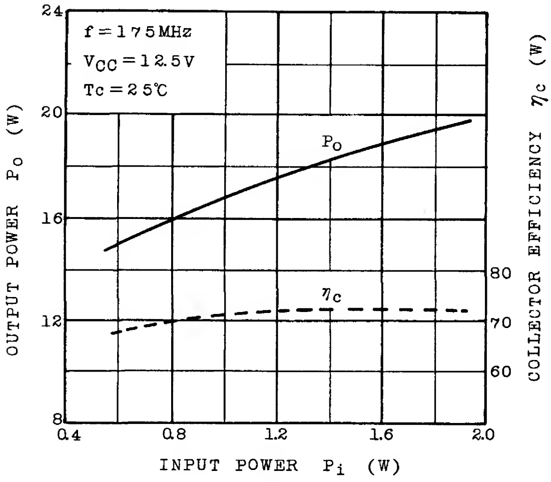
C_6 : 0.01μF CERAMIC CONDENSER

L_1,L_3 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 1T

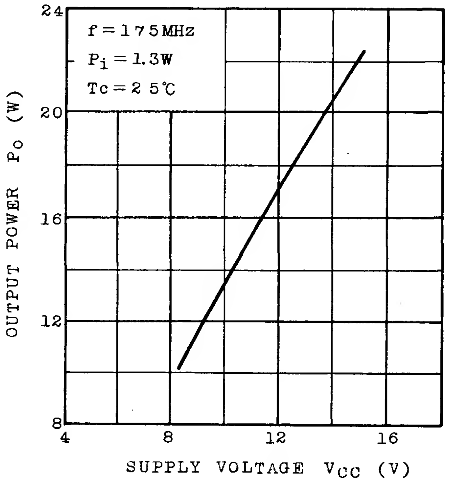
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 2T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 3T

P_o, η_c − P_i



P_o − V_{CC}



SILICON NPN EPITAXIAL PLANAR TYPE

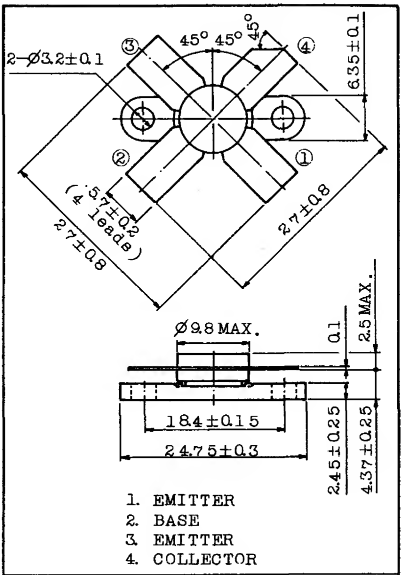
2SC2181

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=40W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=10W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=13.5V, P_i=10W, f=175MHz

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2—10H1A

Weight : 4.0g

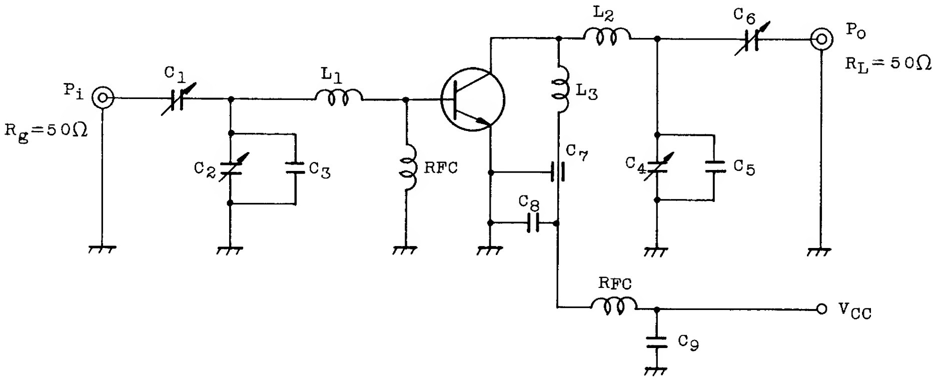
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	10	A
Collector Power Dissipation (Tc=25 °C)	P_C	70	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=20mA, I_E=0	35	-	-	V
Collector-Emitter Breakdwon Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	160	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=10W	40	44	-	W
Power Gain	G_{pe}		6.0	6.4	-	dB
Collector Efficiency	η_c		60	73	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=13.5V, f=175MHz, P_o=40W	-	0.95 -j0.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	2.6 -j0.15	-	Ω

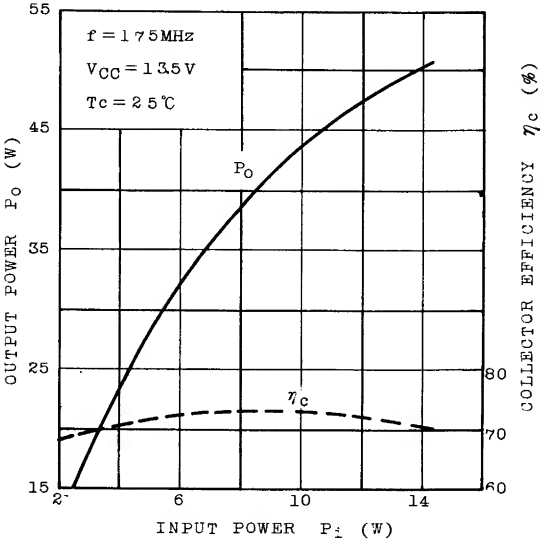
Fig. P_o TEST CIRCUIT



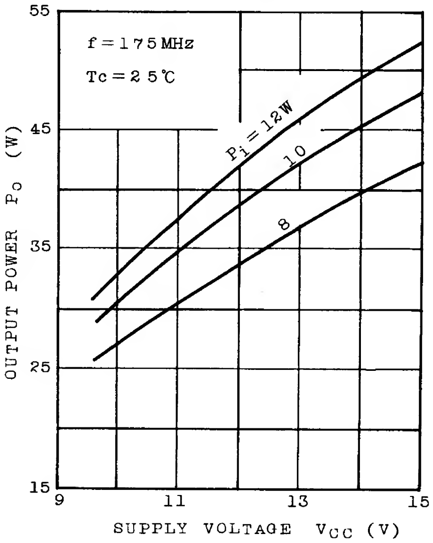
C_1, C_2, C_4, C_6 : 3.5 ~ 30pF
C_3, C_5 : 30pF CERAMIC CONDENSER
C_7 : 1000pF FEED THROUGH
C_8, C_9 : 0.01μF CERAMIC CONDENSER

L_1 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 1/2T
L_2 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 1T
L_3 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 2T
RFC : ϕ1.0 ENAMEL COATED COPPER WIRE, 8ID, 10T

P_o, η_c − P_i



P_o − V_{CC}



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

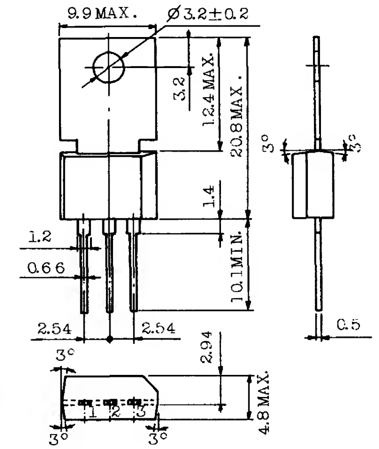
2SC2194A

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Suitable for TV Sound Output, Vert. Deflection Output.
- Designed for Complementary Use with 2SA962A.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR

Collector Connected to Tab.

JEDEC	TO−202
EIAJ	−
TOSHIBA	2−10F1A

Weight : 1.37g

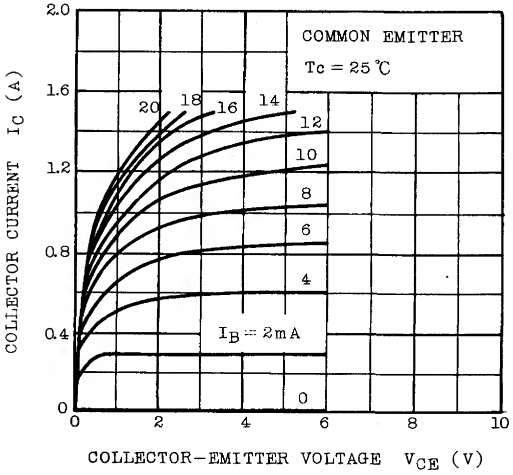
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	1.5	A
Emitter Current	I_E	-1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

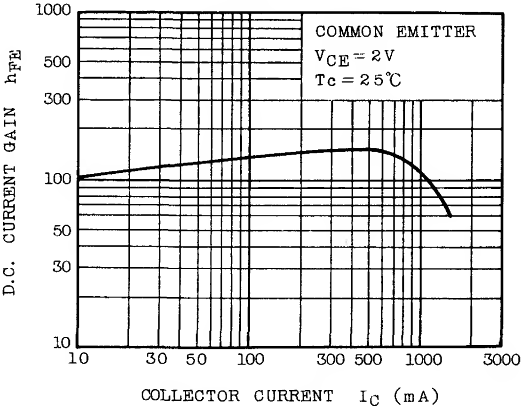
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=50V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	-	-	V
DC Current Gain	h_{FE}	V_{CE}=2V, I_C=150mA	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=1A, I_B=0.1A	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=10V, I_C=10mA	0.50	0.60	0.70	V
Transition Frequency	f_T	V_{CE}=10V, I_C=100mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	20	-	pF

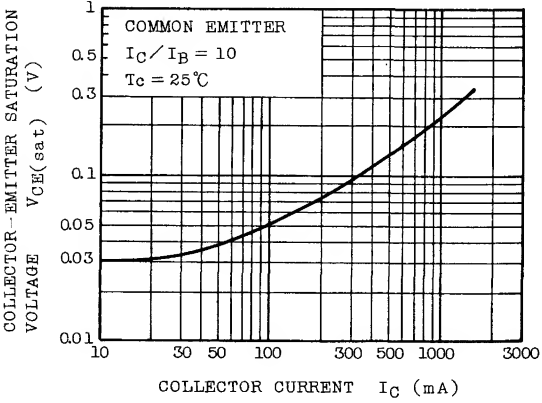
I_C - V_{CE}



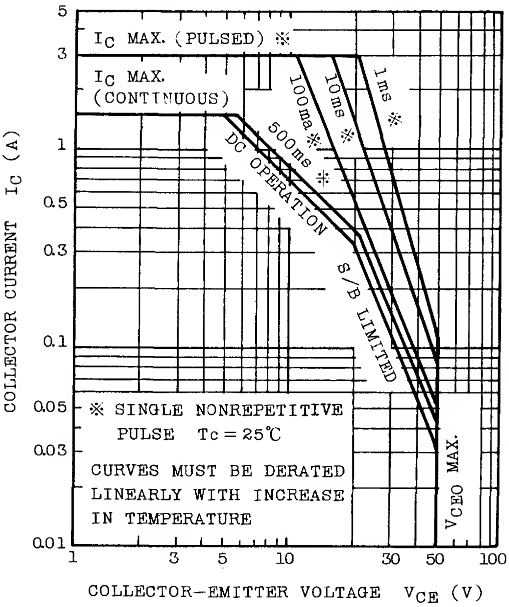
h_{FE} - I_C



$V_{CE(sat)}$ - I_C



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

2SC2200

INDUSTRIAL APPLICATIONS

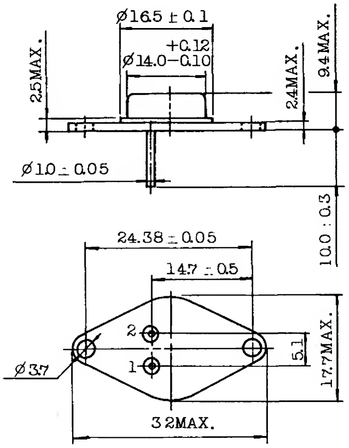
SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Time (I_C=3A)
  : t_r=1.0μs Max. t_f=1.0μs Max.
- High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (HEAT SINK)

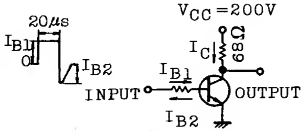
JEDEC	–
EIAJ	–
TOSHIBA	2-14A1A

Mounting Kit No. AC74
Weight : 7.6g

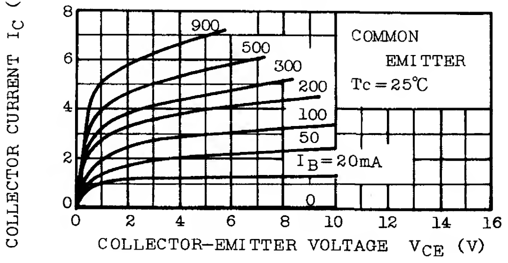
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	7	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

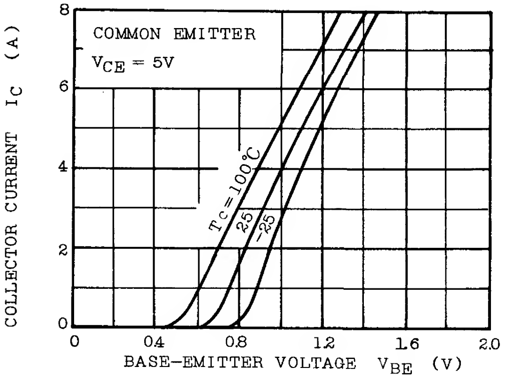
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	7	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=3A	10	-	-	-
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=0.3A	-	-	2.0	V
Switching Time	Rise Time	t_r	 20μs V_{CC}=200V I_{B1} 0 I_{B2} I_C 68Ω I_{B1} INPUT OUTPUT I_{B2} I_{B1}=−I_{B2}=0.3A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.0	
	Fall Time	t_f		-	-	1.0	

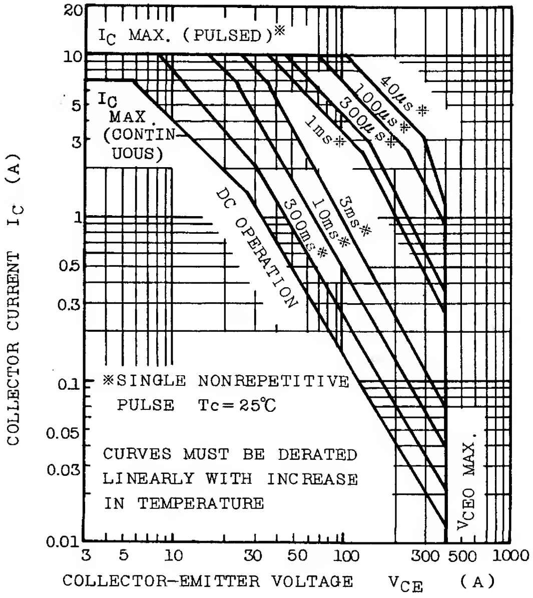
$I_C - V_{CE}$



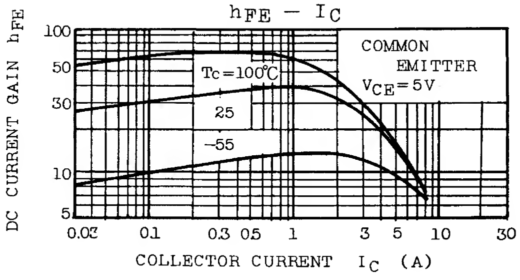
$I_C - V_{BE}$



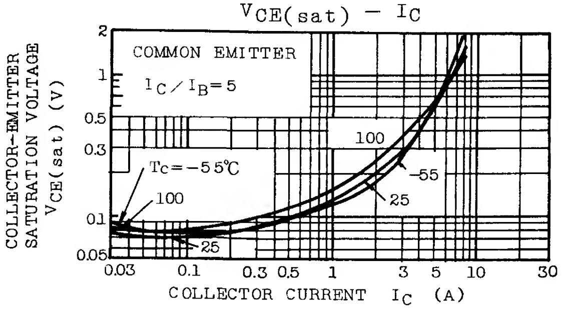
SAFE OPERATING AREA



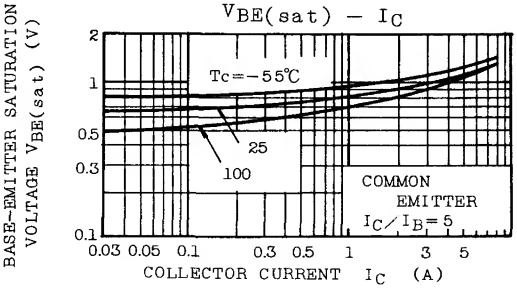
$h_{FE} - I_C$



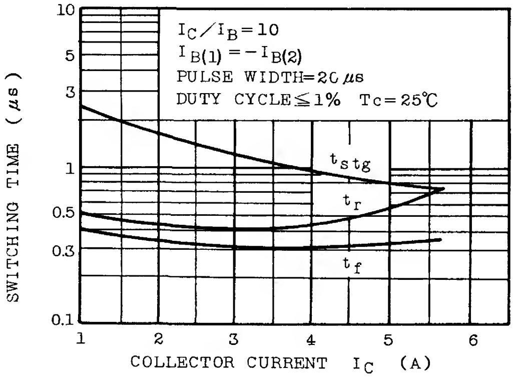
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



SWITCHING CHARACTERISTICS



SILICON NPN TRIPLE DIFFUSED MESA TYPE

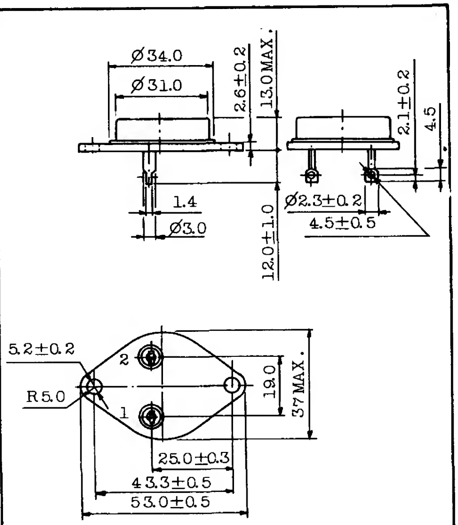
2SC2204
2SC2220

HIGH POWER SWITCHING APPLICATIONS.
HIGH FREQUENCY INVERTOR APPLICATIONS.

FEATURES :

- High Voltage : V_{CEO}=400V(Min.)(2SC2204)
  V_{CEO}=300V(Min.)(2SC2220)
  V_{CBO}=800V(Min.)(2SC2204)
  V_{CBO}=500V(Min.)(2SC2220)
- High Speed Switching : t_f=0.7μs(Typ.)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

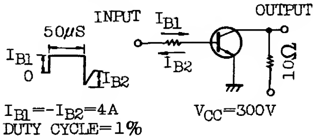
JEDEC	-
EIAJ	TC-19, TB-30
TOSHIBA	2-31B1A

Mounting kit No.AC63
Weight : 46g

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC2204	V_{CBO}	800	V
	2SC2220		500	
Collector-Emitter Voltage	2SC2204	V_{CEO}	400	V
	2SC2220		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	30	A
Emitter Current		I_E	-30	A
Base Current		I_B	15	A
Collector Power Dissipation		P_C	250	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65∿150	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC2204	I_{CBO}	V_{CB}=800V, I_E=0	-	-	1.0	mA
	2SC2220		V_{CB}=500V, I_E=0				
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5	mA
Collector-Emitter Breakdown Voltage	2SC2204	$V_{(BR)CEO}$	I_C=20mA, I_B=0	400	-	-	V
	2SC2220			300	-	-	
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=30A	10	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=30A, I_B=6A	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=30A, I_B=6A	-	-	2.0	
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	t_{on}	 50μS INPUT I_{B1} OUTPUT I_{B1} 0 I_{B2} I_{B2} 10Ω I_{B1}=-I_{B2}=4A DUTY CYCLE=1% V_{CC}=300V	-	1.2	1.5	μs
	Storage Time	t_{stg}		-	3.0	4.0	
	Fall Time	t_f		-	0.7	1.0	

2SC2231
2SC2231A

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

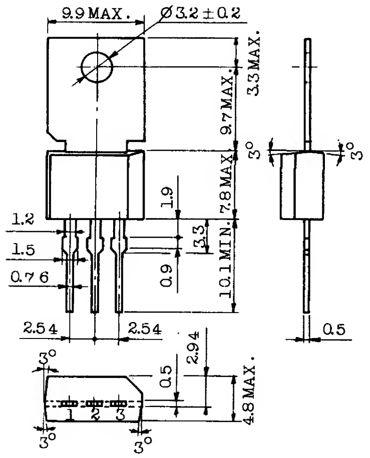
HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.

COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=180V (2SC2231A)

Unit in mm



1. BASE
2. COLLECTOR
   (COLLECTOR CONNECTED TO TAB)
3. EMITTER

JEDEC	TO-202
EIAJ	—
TOSHIBA	2-10F1B

Weight :1.4g

MAXIMUM RATINGS (Ta=25°C)

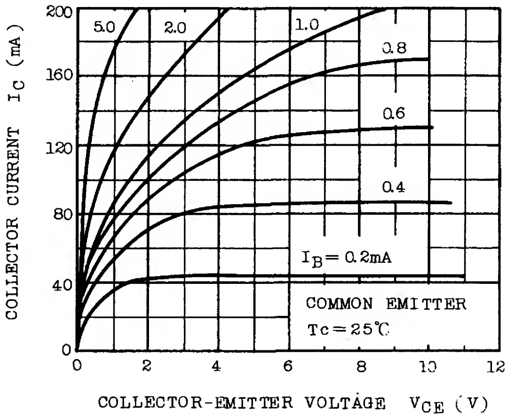
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	200	V
Collector-Emitter Voltage	2SC2231	V_{CEO}	160	V
	2SC2231A		180	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	200	mA
Base Current		I_B	100	mA
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		12	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

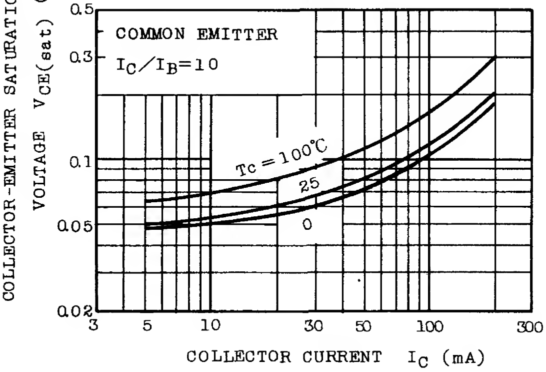
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	0.1	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.1	μA
DC Current Gain	$h_{FE}(1)$ (Note)	V_{CE}=10V, I_C=50mA	100	-	320	-
	$h_{FE}(2)$	V_{CE}=10V, I_C=150mA	80	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=200mA, I_B=20mA	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=10V, I_C=5mA	0.55	0.65	0.75	V
Transition Frequency	f_T	V_{CE}=10V, I_C=50mA	50	-	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	10	pF

Note : $h_{FE(1)}$ Classification O:100~200, Y:160~320

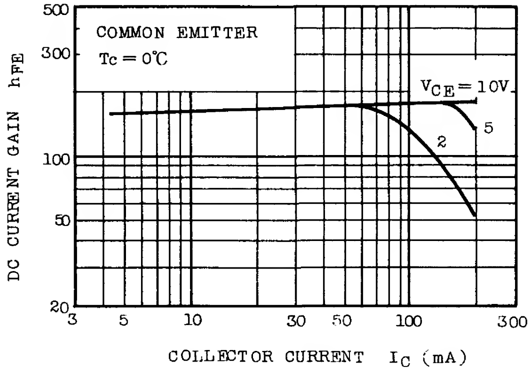
I_C - V_{CE}



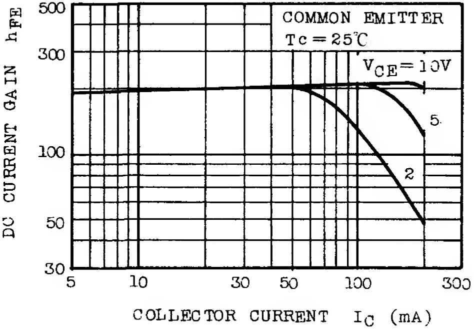
$V_{CE(sat)}$ - I_C



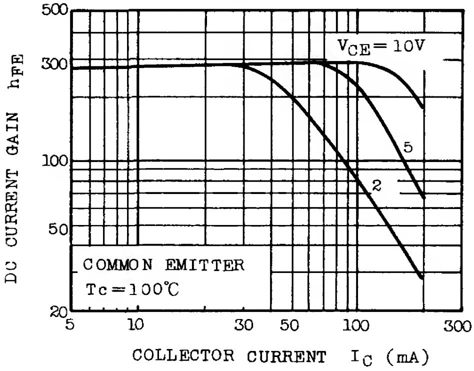
h_{FE} - I_C



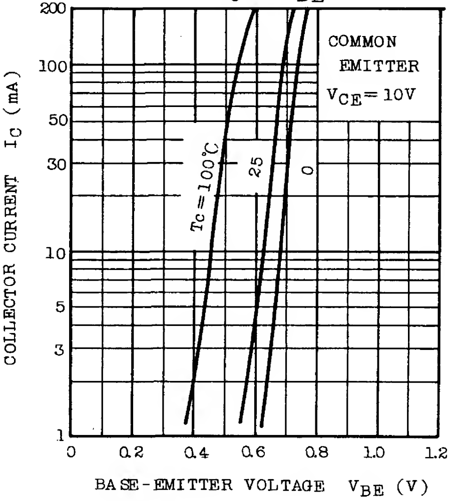
h_{FE} - I_C



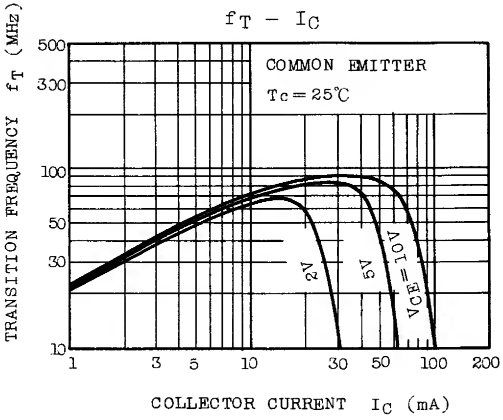
h_{FE} - I_C



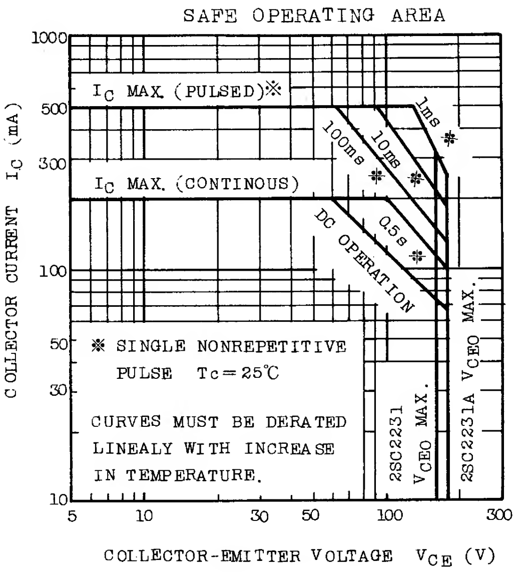
I_C - V_{BE}



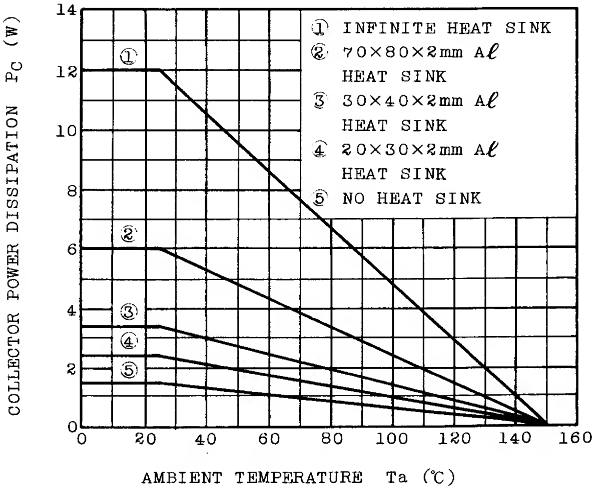
f_T — I_C



SAFE OPERATING AREA



P_C — Ta



SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

2SC2233

TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.

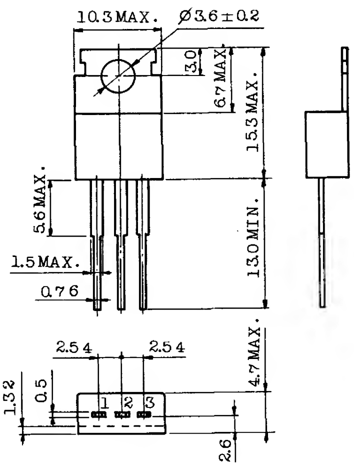
FEATURES:

- Large Collector Current Capability.
- Large Collector Power Dissipation Capability.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	200	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	4	A
		I_{CP}	10	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

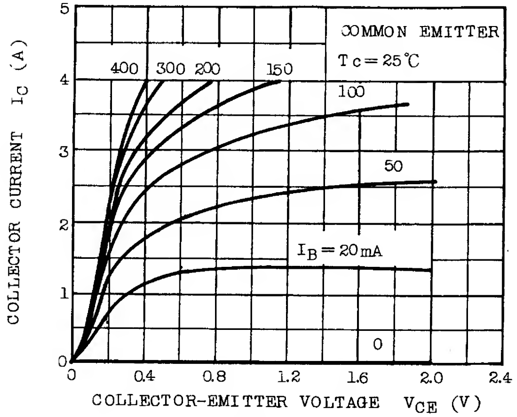
Weight: 1.9g

Mounting kit No. AC75

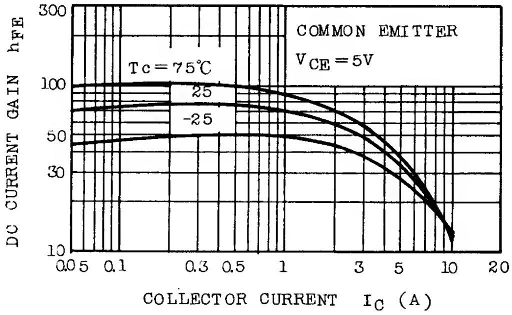
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=170V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
DC Current Gain	$h_{FE}(1)$	V_{CE}=5V, I_C=1A	30	-	150	
	$h_{FE}(2)$	V_{CE}=5V, I_C=4A	20	40	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=0.4A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	-	8	-	MHz

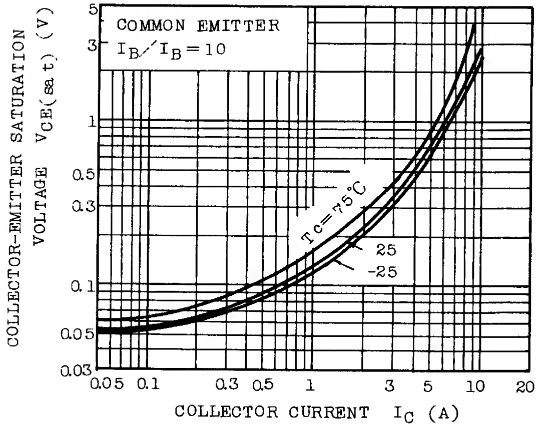
I_C - V_{CE}



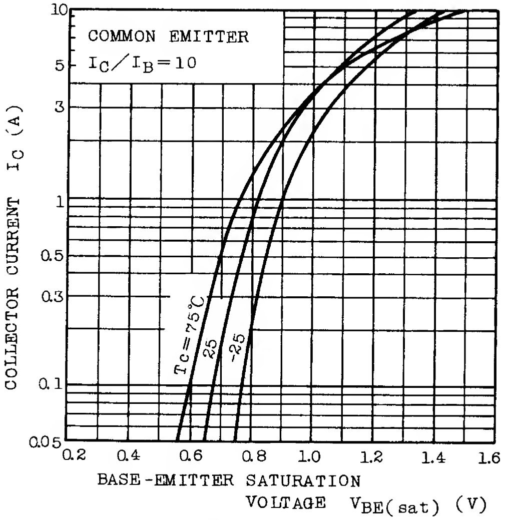
h_{FE} - I_C



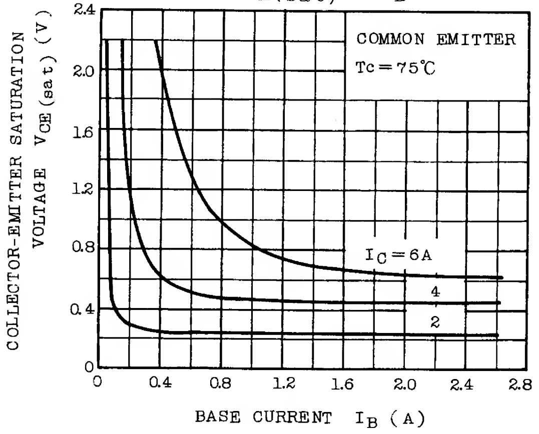
$V_{CE(sat)}$ - I_C



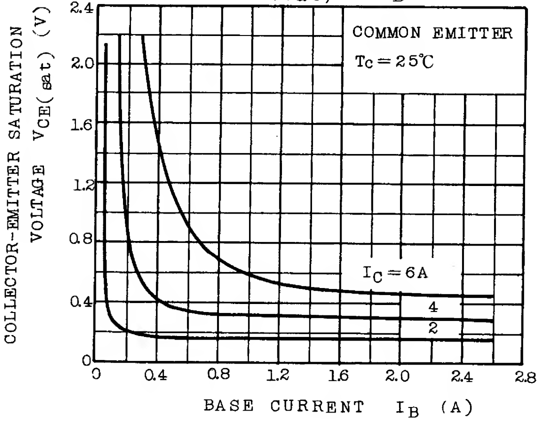
I_C - $V_{BE(sat)}$



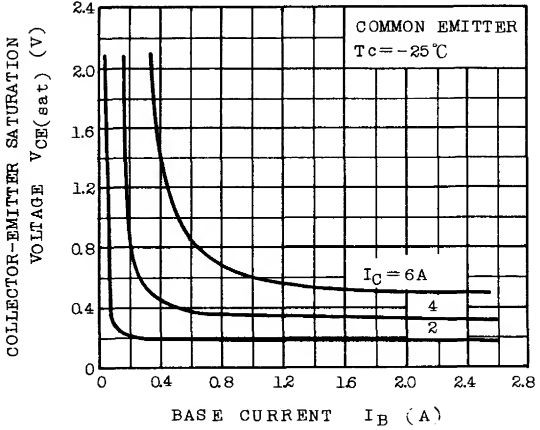
$V_{CE(sat)}$ - I_B



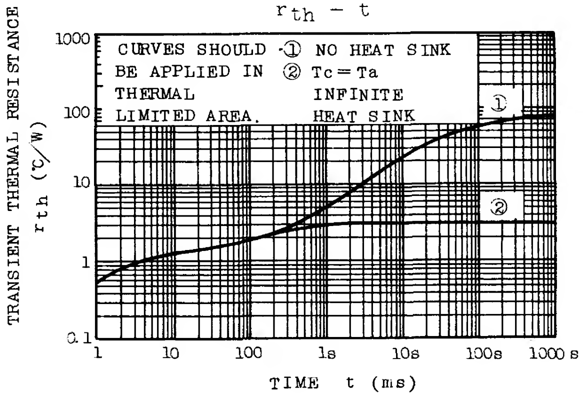
$V_{CE(sat)}$ - I_B



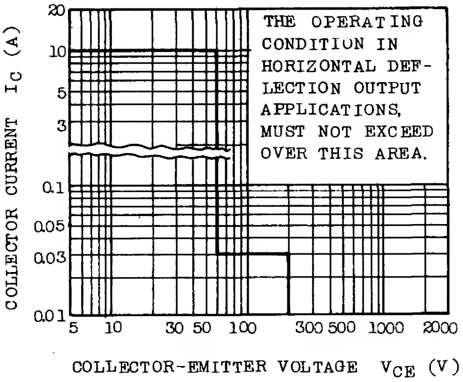
$V_{CE(sat)} - I_B$



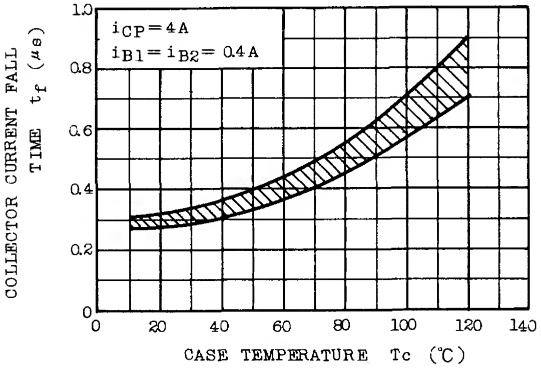
$r_{th} - t$



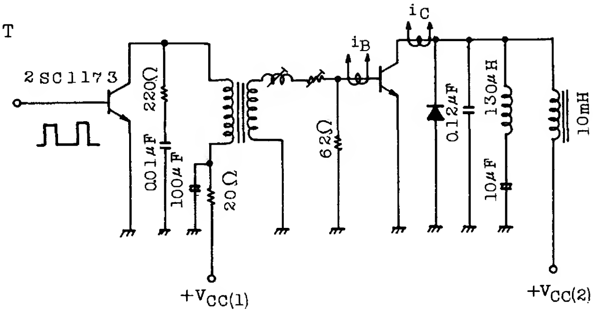
SAFE OPERATING AREA

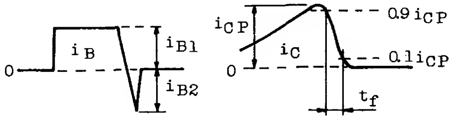


$t_f - Tc$



TEST CIRCUIT





2SC2238
2SC2238A
2SC2238B

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

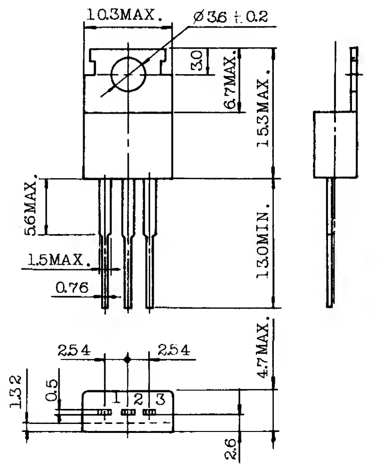
POWER AMPLIFIER APPLICATIONS.

DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=100MHz (Typ.)
- Complementary to 2SA968, 2SA968A, and 2SA968B.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

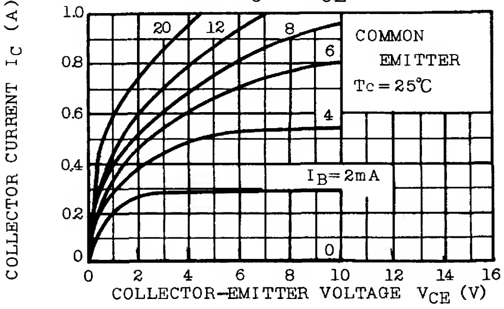
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC2238	V_{CBO}	160	V
	2SC2238A		180	
	2SC2238B		200	
Collector-Emitter Voltage	2SC2238	V_{CEO}	160	V
	2SC2238A		180	
	2SC2238B		200	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Emitter Current		I_E	-1.5	A
Collector Power Dissipation (Tc=25°C)		P_C	25	W
Junction Temperature		Tj	150	°C
Storage Temperature Range		Tstg	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

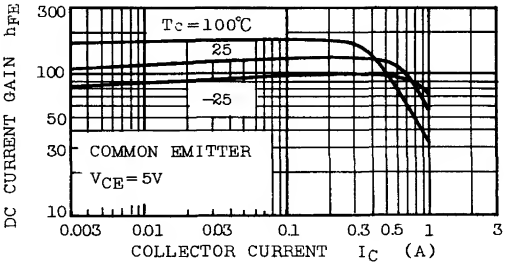
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=160V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	2SC2238	$V_{(BR)CEO}$	I_C=10mA, I_B=0	160	-	-	V
	2SC2238A			180	-	-	
	2SC2238B			200	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=100mA	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=100mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	25	-	pF

Note : h_{FE} Classification O : 70~140, Y : 120~240

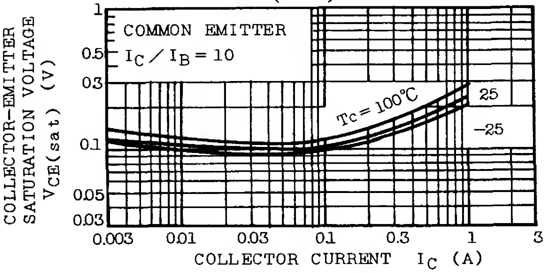
I_C — V_{CE}



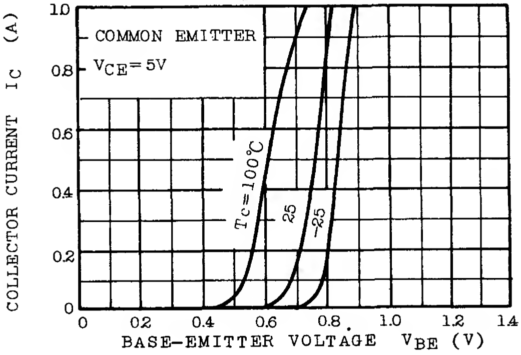
h_{FE} — I_C



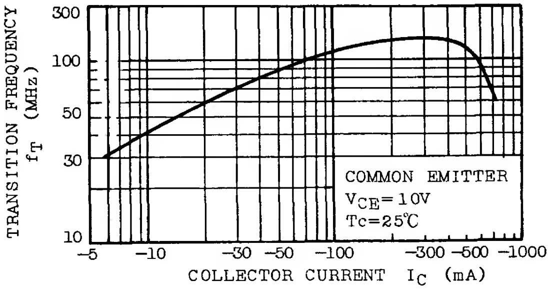
$V_{CE(sat)}$ — I_C



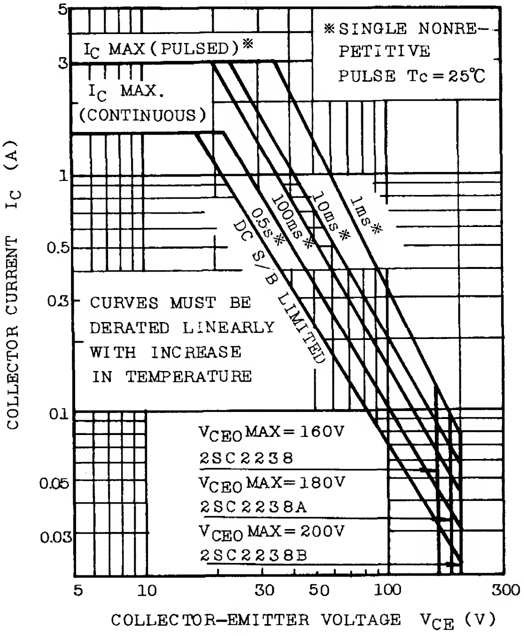
I_C — V_{BE}



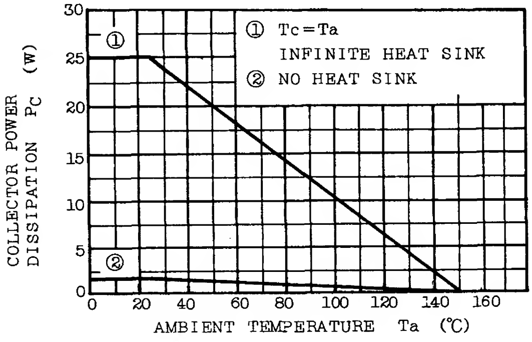
f_T — I_C



SAFE OPERATING AREA



P_C — Ta



2SC2242

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

COLOR TV SOUND OUTPUT APPLICATIONS.

FEATURES:

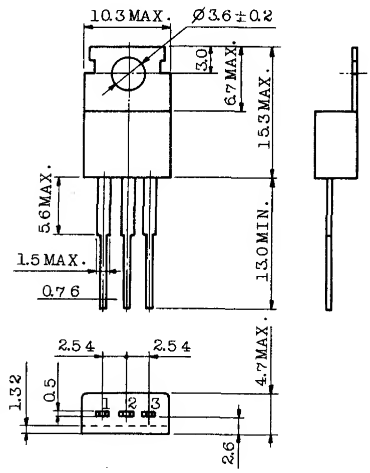
. Recommended for Sound Output Stage in Line Operated TV.

. High Voltage : V_{CEO}=300V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	300	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	150	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C	P_C	25	
Junction Temperature		T_j	150	°C
Storage Temperature		Tstg	-55~150	°C

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

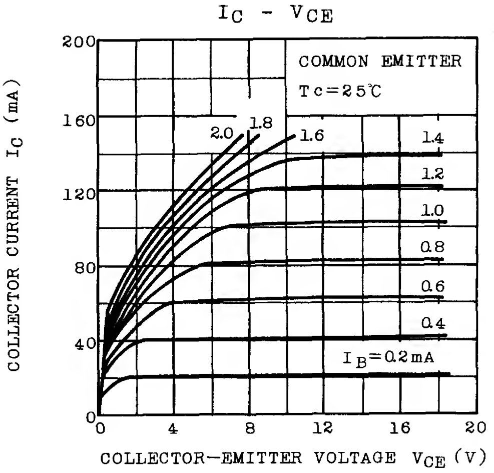
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

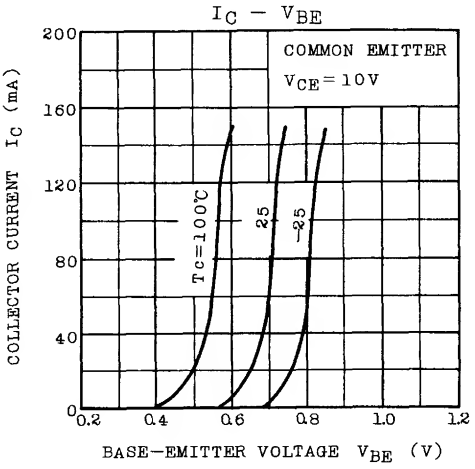
Weight : 1.9g

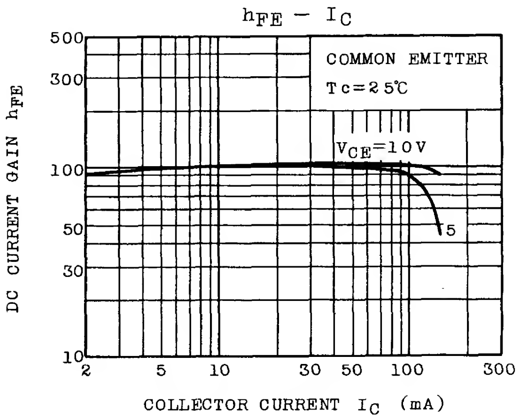
Mounting kit No. AC75

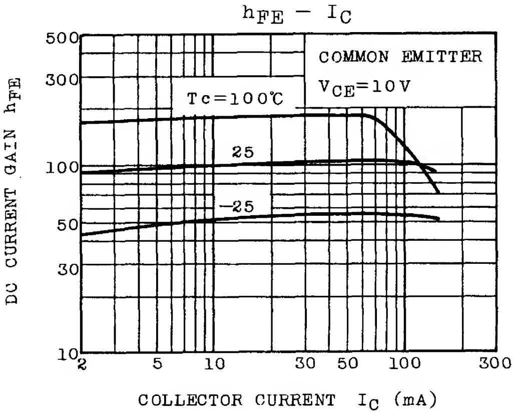
ELECTRICAL CHARACTERISTICS (Ta=25°C)

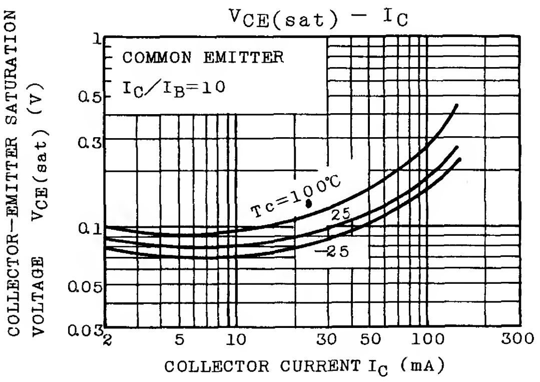
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=240V, I_E=0	–	–	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	–	–	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	300	–	–	V
DC Current Gain	h_{FE}	V_{CE}=10V, I_C=50mA	40	–	170	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=100mA, I_B=10mA	–	–	3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=10V, I_C=50mA	0.6	–	0.9	V
Transition Frequency	f_T	V_{CE}=50V, I_C=20mA	20	50	–	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	–	5.5	12	pF

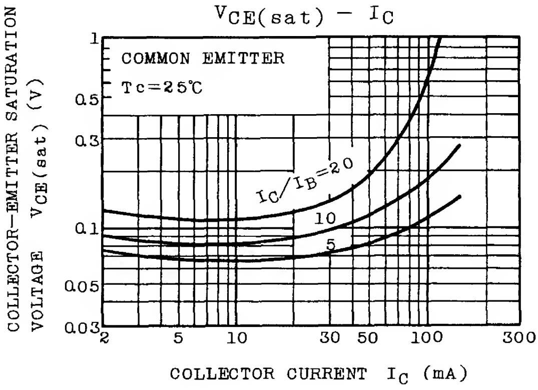

I_C – V_{CE}

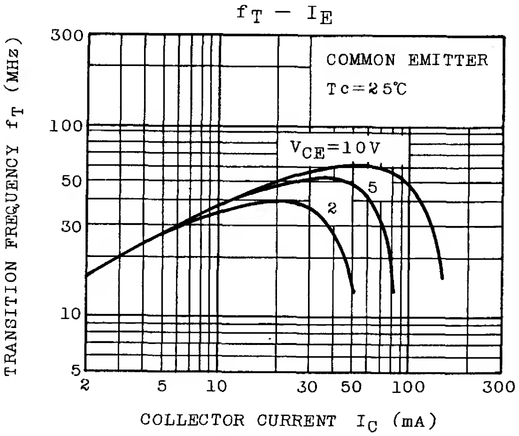

I_C – V_{BE}

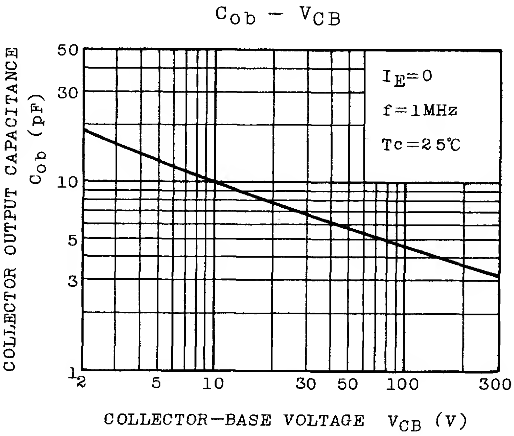

h_{FE} – I_C

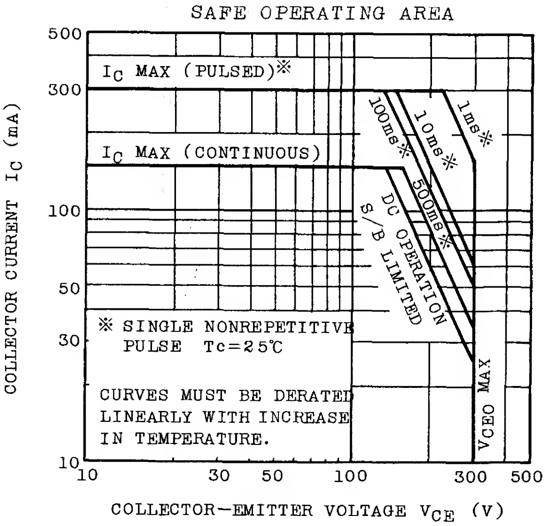

h_{FE} – I_C


$V_{CE(sat)}$ – I_C


$V_{CE(sat)}$ – I_C


fT — IE
COMMON EMITTER
Tc=25℃
VCE=10V
5
2
TRANSITION FREQUENCY fT (MHz)
300
100
50
30
10
5
2
5
10
30
50
100
300
COLLECTOR CURRENT IC (mA)


Cob — VCB
IE=0
f=1MHz
Tc=25℃
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
50
30
10
5
3
1
2
5
10
30
50
100
300
COLLECTOR—BASE VOLTAGE VCB (V)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
100ms※
10ms※
1ms※
500ms※
DC OPERATION
S/B LIMITED
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
COLLECTOR CURRENT IC (mA)
500
300
100
50
30
10
10
30
50
100
300
500
COLLECTOR—EMITTER VOLTAGE VCE (V)

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC2270

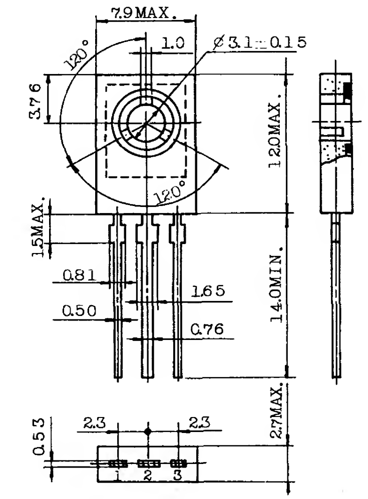
STROBO FLASH APPLICATIONS.

MEDIMUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=140∿450 (V_{CE}=2V, I_C=0.5A)
  h_{FE}=70 (Min.)(V_{CE}=2V, I_C=4A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.0V(Max.) (I_C=4A, I_B=0.1A)
- High Collector Power Dissipation
  : P_C=10W (Tc=25°C), P_C=1.0W (Ta=25°C)

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
HIAJ	-
TOSHIBA	2-8F1A

Mounting Kit No. AC46C
Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CES}	40	V
		V_{CEO}	20	
Emitter-Base Voltage		V_{EBO}	8	V
Collector Current	DC	I_C	5	A
	Pulsed (Note 1)	I_{CP}	8	A
Emitter Current	DC	I_E	-5	A
	Pulsed (Note 1)	I_{EP}	-8	
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-55∿150	°C

Note 1 : Pulse Test :
Pulse Width = 10ms (Max.)
Duty Cycle = 30 % (Max.)

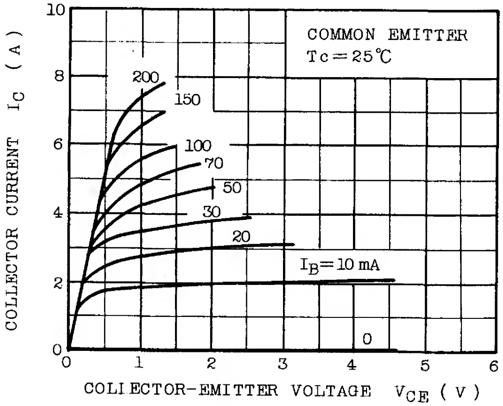
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=40V, I_E=0	-	-	100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=8V, I_C=0	-	-	100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	V_{CE}=2V, I_C=0.5A	140	-	450	
	$h_{FE(2)}$	V_{CE}=2V, I_C=4A	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.1A	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=4A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	40	-	pF

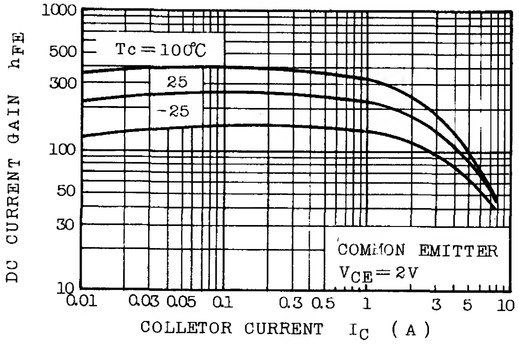
Note 2 : $h_{FE(1)}$ Classification A : 140∿240, B : 200∿330, C : 300∿450

2SC2270

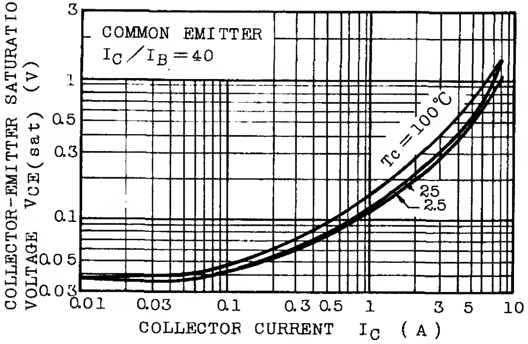
I_C - V_{CE}



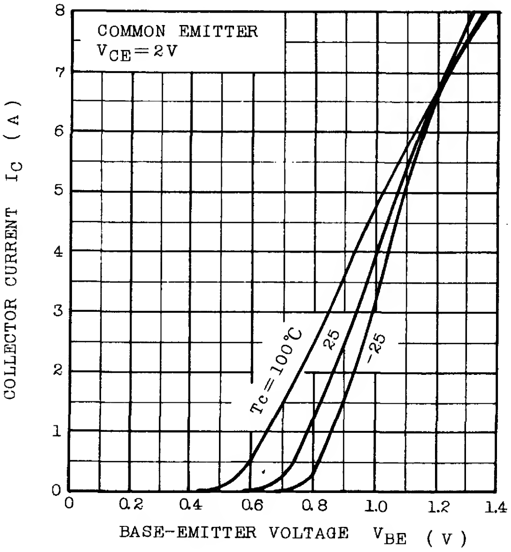
h_{FE} - I_C



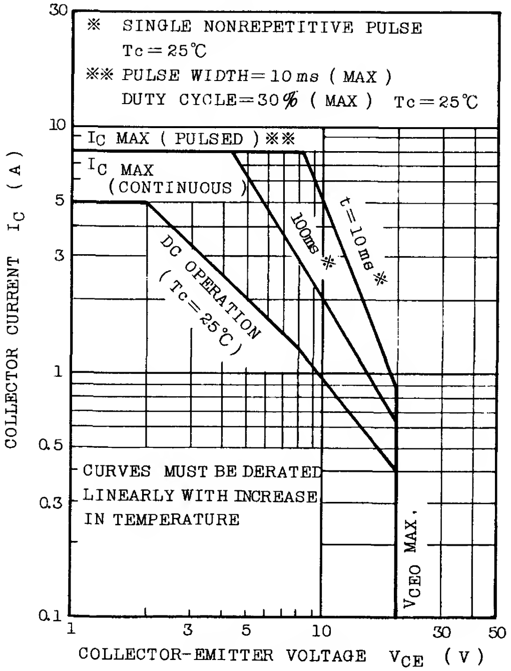
$V_{CE(sat)}$ - I_C



I_C - V_{BE}



SAFE OPERATING AREA



SILICON NPN EPITAXIAL PLANAR TYPE

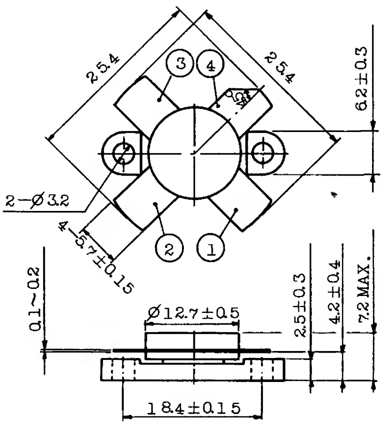
2SC2290

2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES :

- Specified 12.5V, 28MHz Characteristics
  - : Output Power : P_o=60W_{PEP}
  - : Minimum Gain : Gpe=11.8dB
  - : Efficiency : η_c=35%(Min.)
  - : Intermodulation Distortion : IMD=-30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−13B1A

Weight : 5.2g

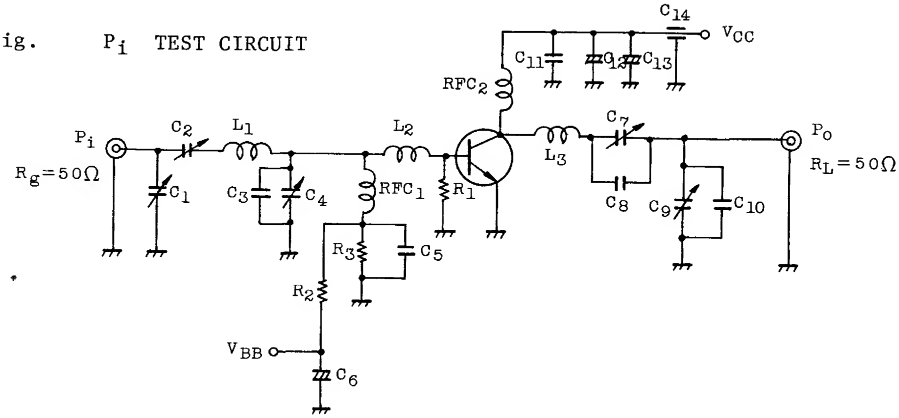
MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	45	V
Collector-Emitter Voltage	V_{CES}	45	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collecotr Power Dissipation (Tc=25 °C)	P_C	175	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=100mA, V_{EB}=0	45	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=10A	10	-	150	
Collector Output Capacitance	C_{ob}	V_{CB}=12.5V, I_E=0, f=1MHz	-	-	500	pF
Power Gain	G_{pe}	V_{CC}=12.5V, f=28MHz 2-Tone, Δf=1kHz I_{idle}=50mA, P_o=60W_{PEP} (Fig.)	11.8	13.8	-	dB
Input Power	P_i		-	2.5	4	W_{PEP}
Collector Efficiency	η_c		35	-	-	%
Intermodulation Distortion	IMD		-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=28MHz Δf=1kHz, P_o=60W_{PEP}	-	1.02 -j0.17	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	0.86 -j0.21	-	Ω

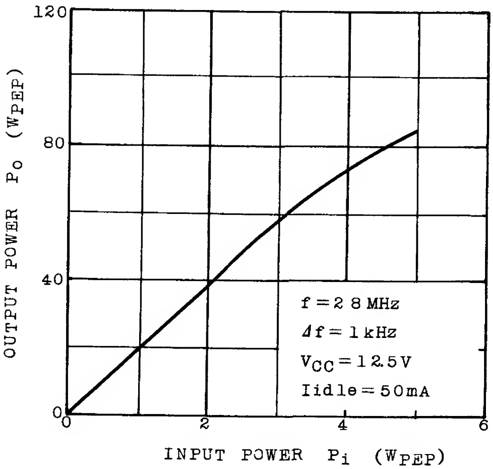
Fig. P_i TEST CIRCUIT



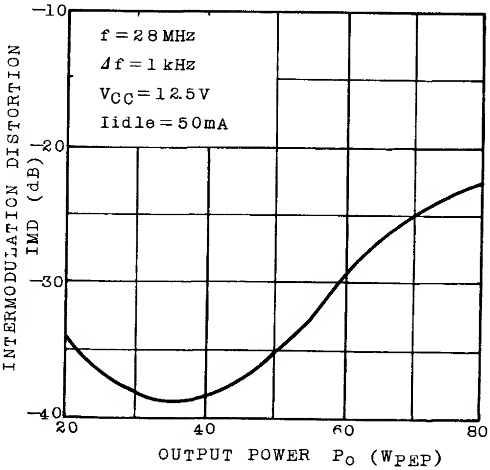
C_1, C_2, C_4, C_7 : 7 ~150pF
C_9 : 10 ~ 200pF
C_3 : 250pF
C_5 : 0.4μF
C_6 : 100μF 10WV
C_8 : 150pF
C_{10} : 600pF
C_{11}, C_{12} : 22μF 35WV
C_{13} : 0.4μF
C_{14} : 1000pF
(FEED THROUGH)

L_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 9ID, 2T
L_3 : ϕ1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T
RFC_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T
RFC_2 : ϕ1.5 ENAMEL COATED COPPER WIRE, 12ID, 15T
R_1 : 5.6Ω (1/2W)
R_2 : 5Ω (5W)
R_3 : 1.5Ω (10W)

P_o — P_i



IMD — P_o



SILICON NPN EPITAXIAL PLANAR TYPE

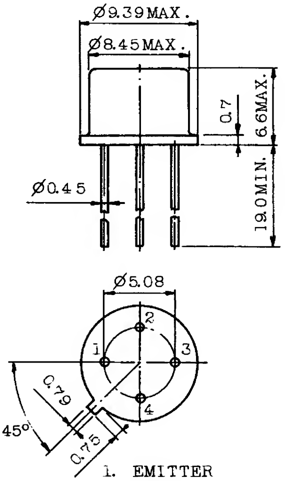
2SC2318

HIGH POWER AMPLIFIER FOR CATV APPLICATIONS.

FEATURES:

- Wide Band and High Gain for Class A Amplifier.
- Excellent Cross Modulation Characteristics.
- All Electrodes Insulated from Case.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

JEDEC	TO-33
EIAJ	TC-5, TB-14B
TOSHIBA	2-8D1A

Weight : 1.13g

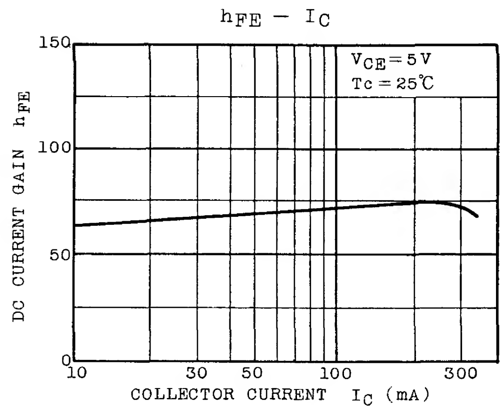
MAXIMUM RATINGS (Ta=25 °C)

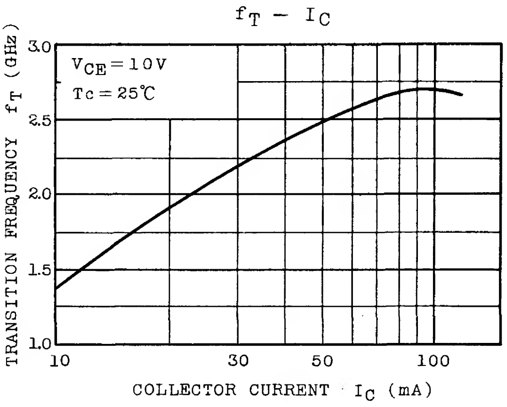
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	15	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	350	mA
Collector Power Dissipation (Tc=25 °C)	P_C	3.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

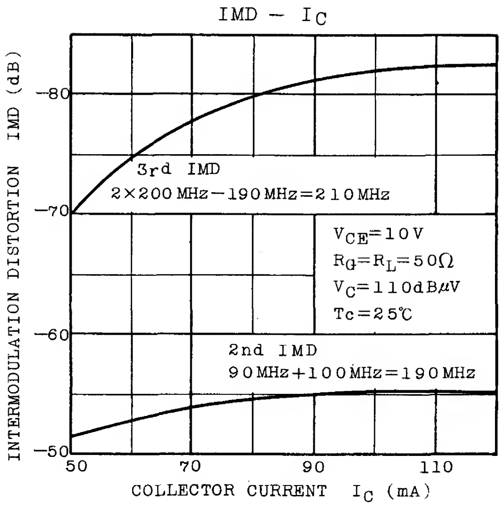
ELECTRICAL CHARACTERISTICS (Ta=25 °C)

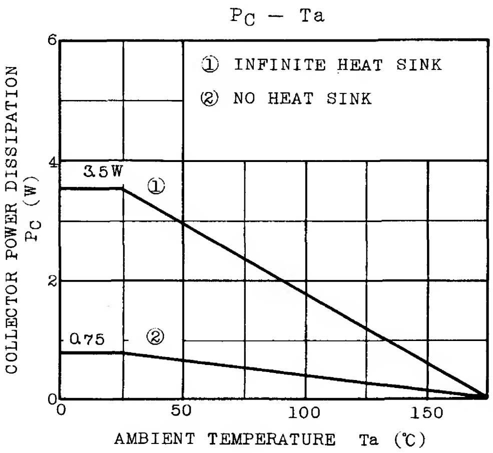
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=30V, I_E=0	-	-	1.0	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	15	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=100mA	30	-	180	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	2.9	3.5	pF
Transition Frequency	f_T	V_{CE}=10V, I_C=90mA	2.0	2.7	-	GHz
Power Gain	$G_{pe}(1)$	V_{CE}=10V, I_C=90mA f=250MHz	14	16	-	dB
	$G_{pe}(2)$	V_{CE}=10V, I_C=90mA f=800MHz	-	6	-	dB

2SC2318


hFE − IC


fT − IC


IMD − IC


PC − Ta

SILICON NPN EPITAXIAL PLANAR TYPE

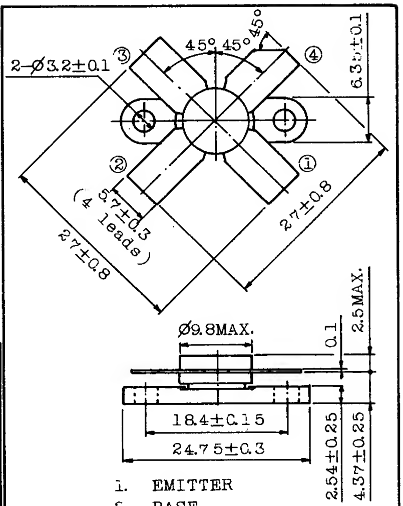
2SC2379

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=6W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=1W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.5V, P_O=6.5W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2-10H1A

Weight : 4g

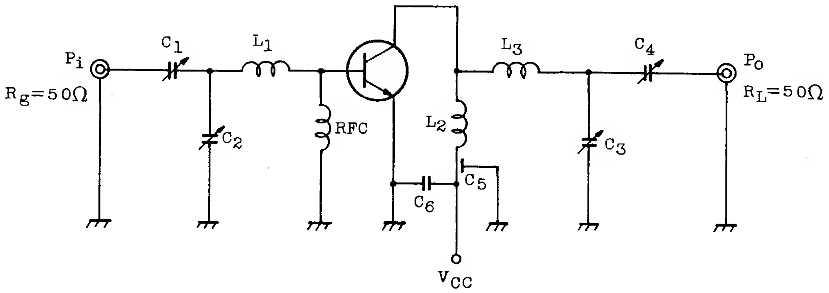
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	165 ~175	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	25	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=1W	6	-	-	W
Power Gain	G_{pe}		7.7	-	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=6W	-	1.4+ j0.9	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.5- j7.2	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1, C_3 : 1.5 ~ 5pF

C_2, C_4 : 2 ~ 15pF

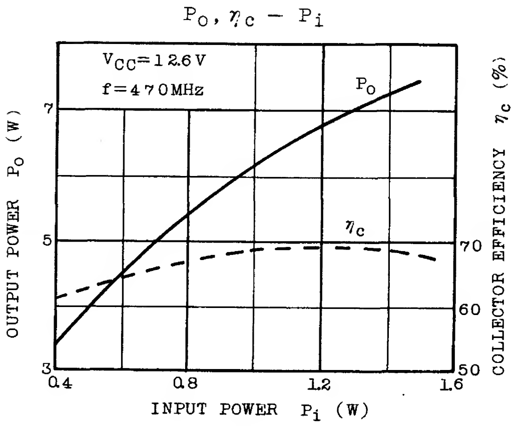
C_5 : 1000pF FEED THROUGH

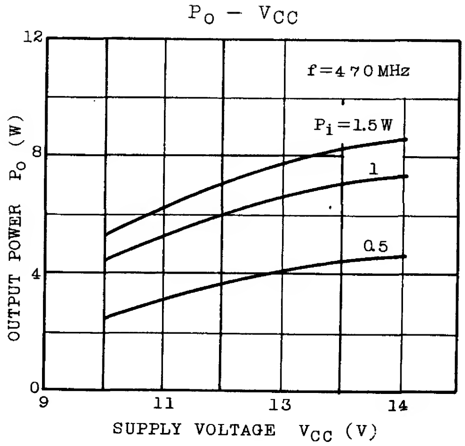
C_6 : 0.01μF

L1,L3 : 5mm × 15mm COPPER PLATE

L2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 3ID, 5T



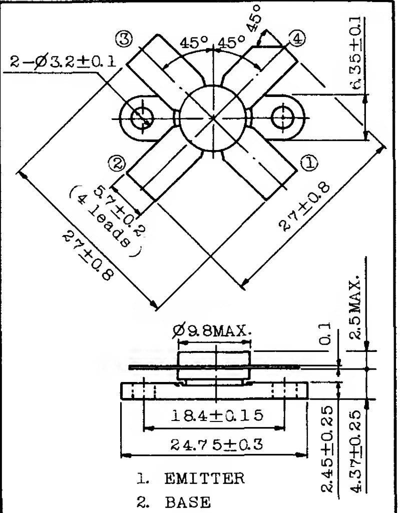


SILICON NPN EPITAXIAL PLANAR TYPE

2SC2380

UHF BAND POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2−10H1A

Weight : 4g

FEATURES:

- Output Power : P_O=12W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=3W, f=470MHz

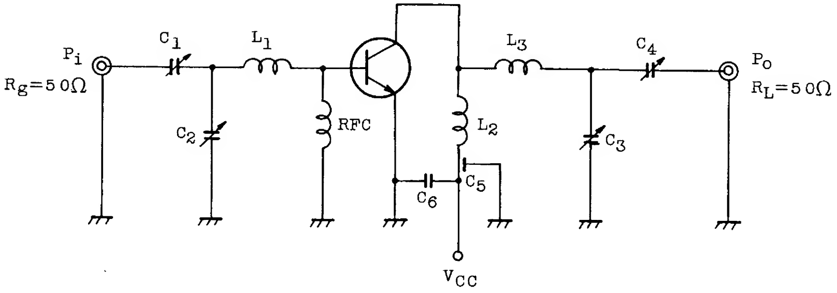
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	165 ~175	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1.5A	10	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	45	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=3W	12	-	-	W
Power Gain	G_{pe}		7.7	-	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=12W	-	1.5+j1.3	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.6−j1.8	-	Ω

Fig. f=470MHz P_O TEST CIRCUIT



C_1, C_3 : 1.5 ~ 5pF

C_2, C_1 : 2 ~ 15pF

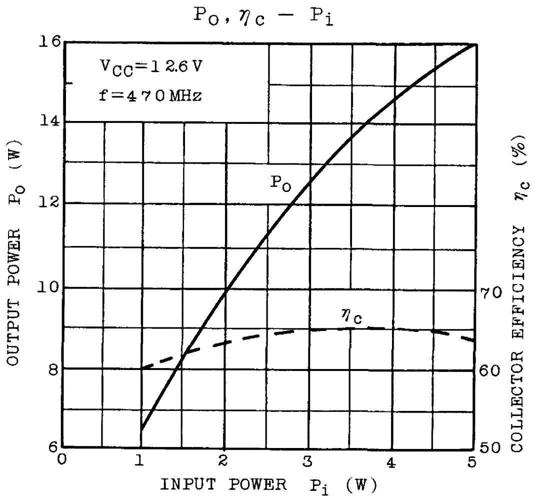
C_5 : 1000pF FEED THROUGH

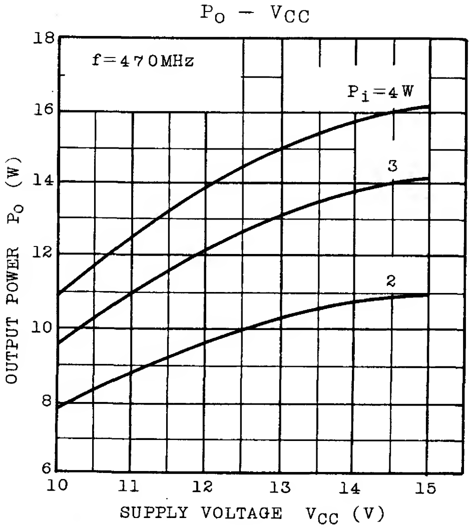
C_6 : 0.01μF

L_1, L_3 : 5mm×15mm COPPER PLATE

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 3ID, 5T



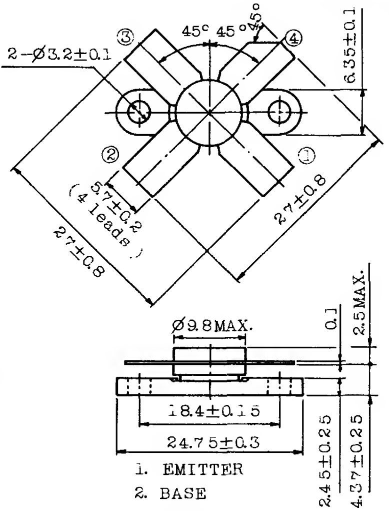


SILICON NPN EPITAXIAL PLANAR TYPE

2SC2381

UHF BAND POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2-10H1A

Weight : 4g

FEATURES:

- Output Power : P_O=25W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=10W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=10W, f=470MHz

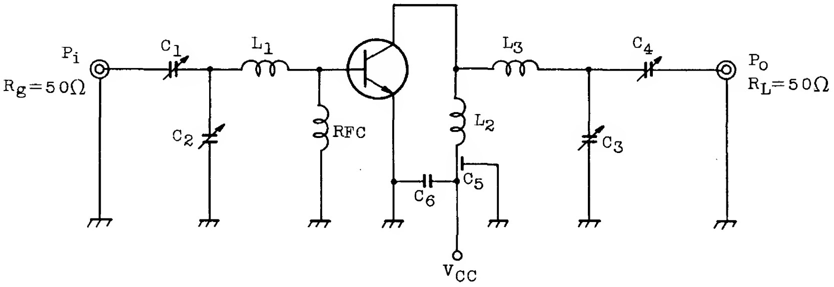
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=3A	10	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=10W	25	28	-	W
Power Gain	G_{pe}		3.9	4.5	-	dB
Collector Efficiency	η_c		60	-	-	%

Fig. f=470MHz P_o TEST CIRCUIT



C_1, C_3 : 1.5 ~ 2pF

C_2, C_3 : 2.2 ~ 15pF

C_5 : 1000pF FEED THROUGH

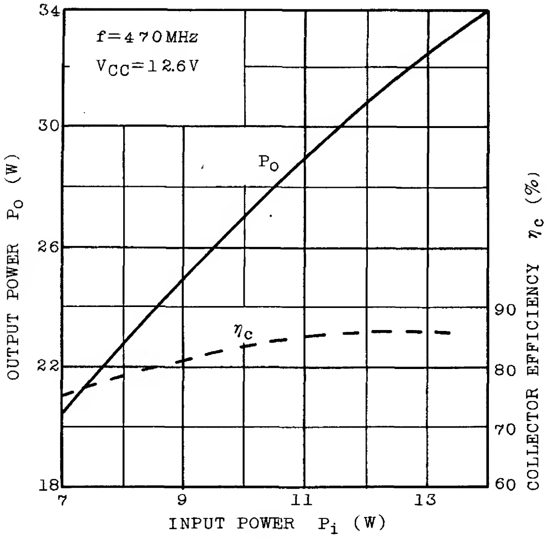
C_6 : 0.01μF

L_1, L_3 : 5mm×15mm COPPER PLATE

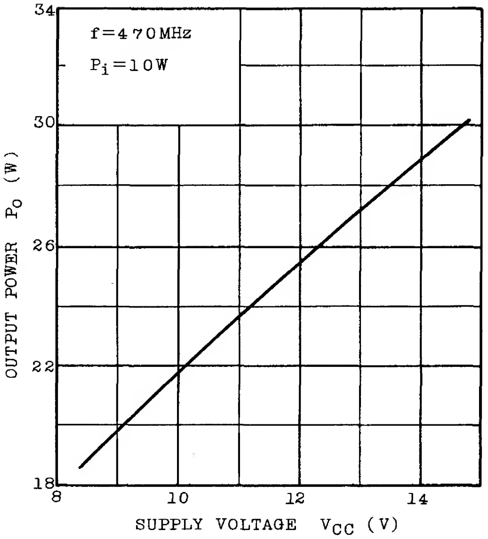
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 3ID, 5T

$P_o, \eta_c - P_i$



$P_o - V_{CC}$



SILICON NPN EPITAXIAL PLANAR TYPE

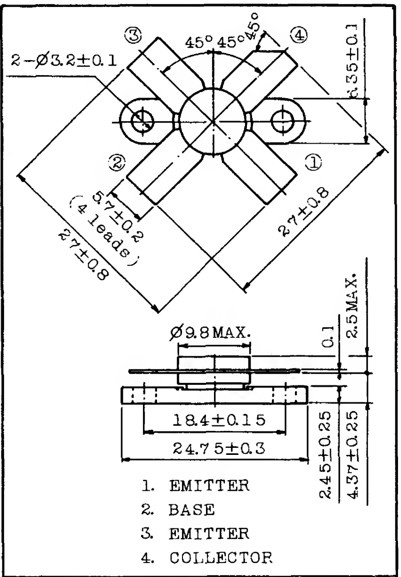
2SC2391

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=3W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=0.4W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=15V, P_i=0.4W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2-10H1A

Weight : 4g

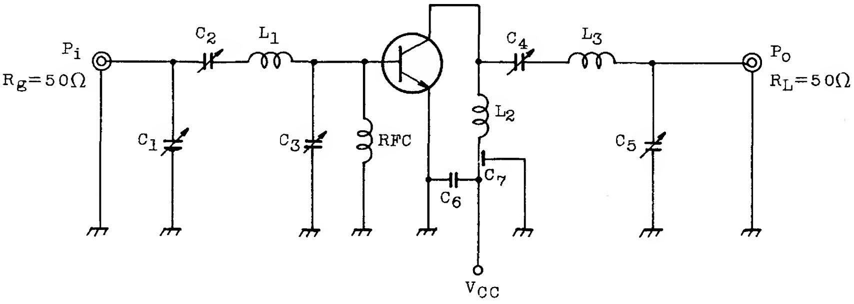
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	7.5	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

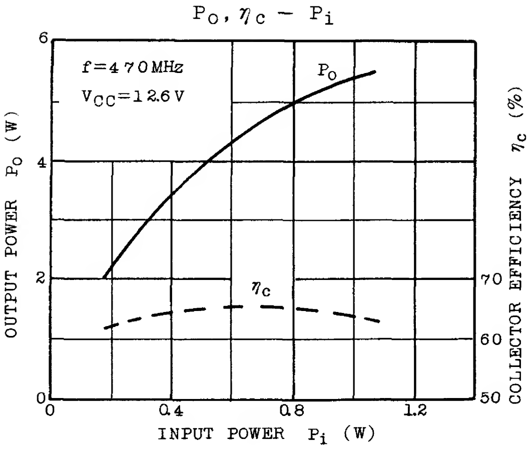
ELECTRICAL CHARACTERISTICS (Ta=25°C)

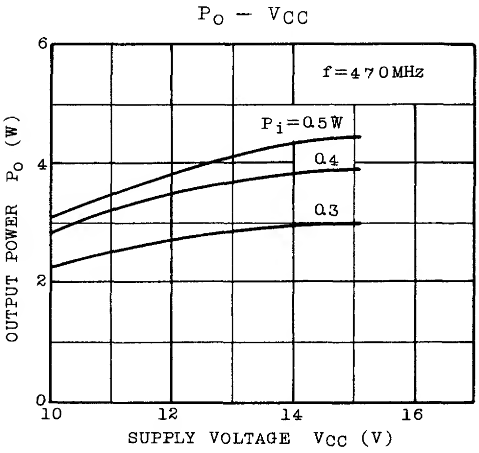
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	20	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=0.4W	3	-	-	W
Power Gain	G_{pe}		4.7	-	-	dB
Collector Efficiency	η_c		50	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=3W	-	1.7+j3.2	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.6-j7.5	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1,C_2,C_3 : ~10pF
C_4,C_5 : ~30pF
C_6 : 0.02μF
C_7 : 1000pF FEED THROUGH
L_1 : ϕ1.6 SILVER PLATED COPPER WIRE, 7ID, ½T
L_2 : ϕ1.2 SILVER PLATED COPPER WIRE, 10ID, 1½T
L_3 : ϕ1.6 SILVER PLATED COPPER WIRE, 10ID, ½T
RFC : ϕ0.7 ENAMEL COATED COPPER WIRE, 3ID, 5T





SILICON NPN EPITAXIAL PLANAR TYPE

2SC2395

2～30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.

(LOW SUPPLY VOLTAGE USE)

FEATURES :

. Specified 12.5V, 28MHz Characteristics

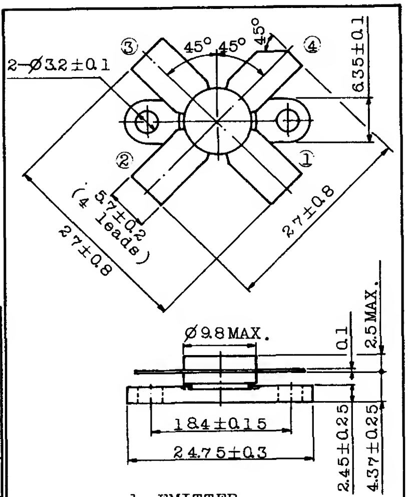
: Output Power : $P_o=10W_{PEP}$

: Minimum Gain : $G_{pe}=17dB$

: Efficiency : $\eta_c=35\%$(Min.)

: Intermodulation Distortion : IMD=-30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2-10H1A

Weight : 4.0g

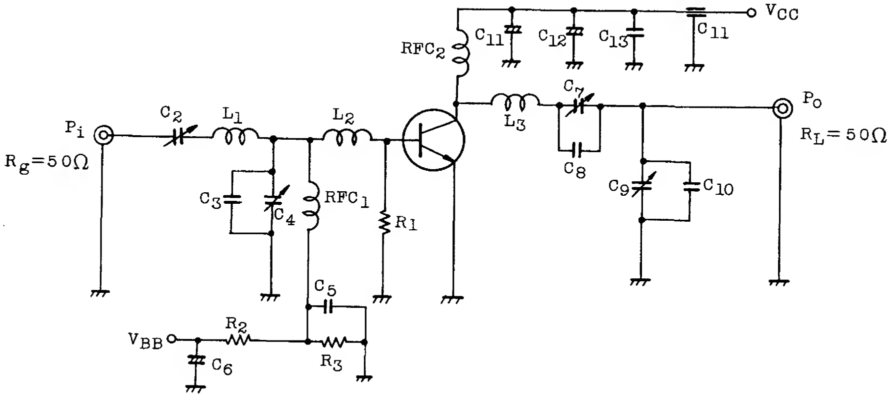
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	5	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

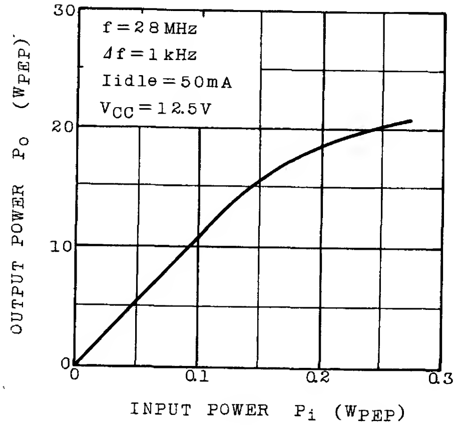
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA,\ I_B=0$	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=50mA,\ V_{EB}=0$	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA,\ I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V,\ I_C=1A$	20	-	-	
Transition Frequency	f_T	$V_{CE}=5V,\ I_C=1A$	-	200	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V,\ I_E=0,\ f=1MHz$	-	-	150	pF
Power Gain	G_{PE}	$V_{CC}=12.5V$, f=28MHz 2-Tone, Δf=1kHz $I_{idle}=50mA,\ P_o=10W_{PEP}$ (Fig.)	17.0	-	-	dB
Input Power	P_i		-	-	0.2	W_{PEP}
Collector Efficiency	η_c		35	45	-	%
Intermodulation Distortion	IMD		-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, f=28MHz Δf=1kHz, $P_o=10W_{PEP}$	-	1.5 -j1.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	6.5 -j2.0	-	Ω

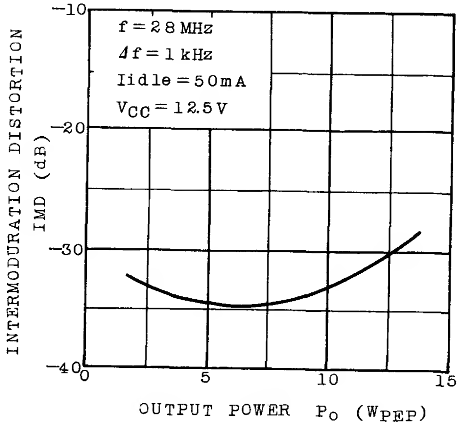
Fig. P_i TEST CIRCUIT



C_2, C_4, C_7 ; 7 ~ 150pF
C_9 : 10 ~ 200pF
C_3 : 200pF
C_5, C_{13} : 0.4μF
C_6 : 100μF 10WV
C_8 : 350pF
C_{10} : 200pF
C_{11}, C_{12} : 22μF 35WV
C_{14} : 1000pF (FEED THROUGH)

L_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T
L_2 : ϕ1 SILVER PLATED COPPER WIRE, 9ID, 2T
L_3 : ϕ1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T
RFC_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T
RFC_2 : ϕ1.5 ENAMEL COATED COPPER WIRE, 12ID, 15T
R_1 : 5.6Ω (1/2W)
R_2 : 5Ω (5W)
R_3 : 1.5Ω (10W)


P_o — P_i


IMD — P_o

SILICON NPN EPITAXIAL PLANAR TYPE

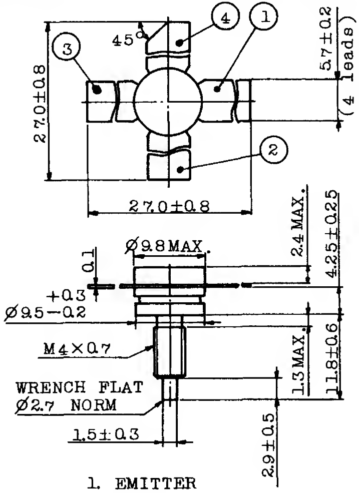
2SC2420

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_o=32W (Min.)
  (f=175MHz, V_{CC}=13.5V, P_i=4W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=14.5V, P_i=4W, f=175MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−10G1A

Mounting Kit No. AC57
Weight : 3.3g

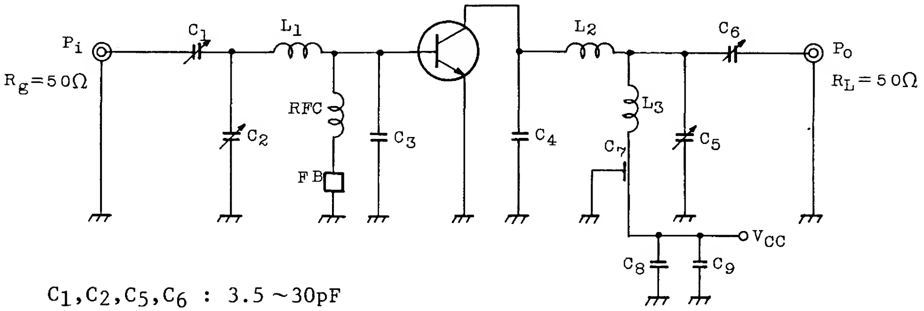
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	70	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

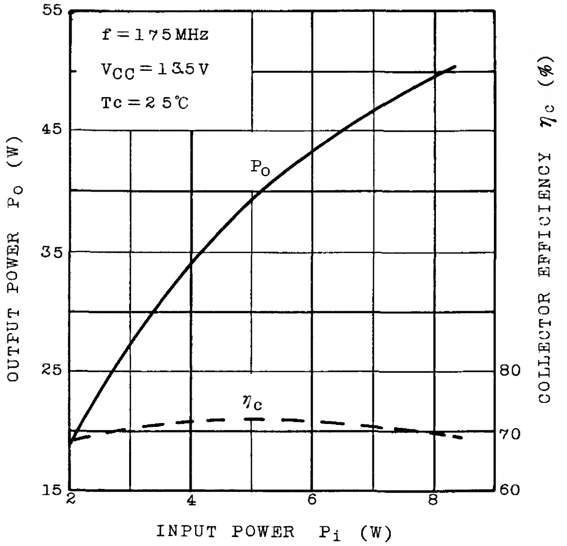
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=5A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=13.5V, I_E=0, f=1MHz	-	110	160	pF
Output Power	P_o	(Fig.) V_{CC}=13.5V, f=175MHz, P_i=4W	32	34	-	W
Power Gain	G_{pe}		9.0	9.3	-	dB
Collector Efficiency	η_c		60	70	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=13.5V, f=175MHz, P_o=32W	-	0.9 +j1.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	2.0 -j0.4	-	Ω

Fig. P_o TEST CIRCUIT



C_1, C_2, C_5, C_6 : 3.5 ~ 30pF
C_3 : 72pF CERAMIC CONDENSER
C_4 : 47pF CERAMIC CONDENSER
C_7 : 1000pF FEED THROUGH
C_8 : 0.01μF CERAMIC CONDENSER
C_9 : 10μF
L_1, L_2 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 1T
L_3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T
RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 10T
FB : FERRITE BEADS

$P_o, \eta_c - P_i$



SILICON NPN TRIPLE DIFFUSED MESA TYPE

2SC2444

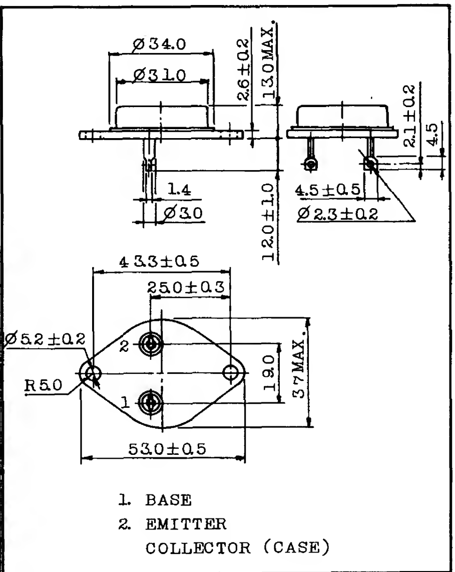
INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS.
HIGH FREQUENCY INVERTER APPLICATIONS.
SWITCHING REGULATER APPLICATIONS.

FEATURES:

. High Collector Emitter Voltage

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

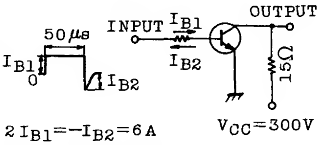
JEDEC	—
EIAJ	TC−19 , TB−30
TOSHIBA	2 − 31B1A

Mounting kit No. AC227 & AC88B
Weight : 50g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	30	A
Peak Collector Current	I_C peak	60 (1 ms)	A
Base Current	I_B	10	A
Collector Power Dissipation	P_C	250	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=500V, I_E=0	-	-	0.2	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.2	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=20A	10	-	-	
			V_{CE}=5V, I_C=30A	5	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=20A, I_B=3A	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.0	V
Collector Output Capacitance		C_{ob}	V_C=50V, I_E=0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	t_{on}		-	-	1.5	μs
	Storage Time	t_{stg}		-	-	3.0	
	Fall Time	t_f	2 I_{B1}=−I_{B2}=6 A DUTY CYCLE=1%	-	-	1.0	

2SC2456

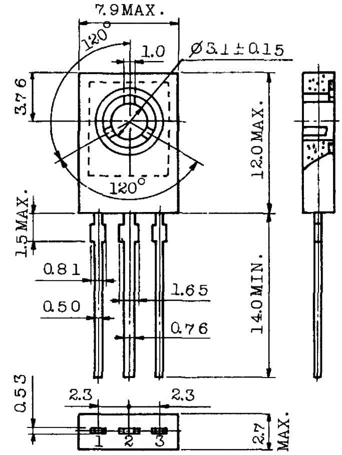
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

COLOR TV HORIZONTAL DRIVER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=300V
- Recommended for Chroma Output and Horizontal Driver Application for Line Operated TV.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

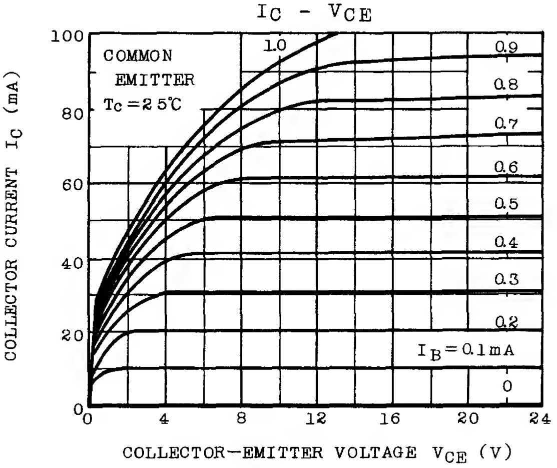
Mounting Kit No. AC46C
Weight : 0.72g

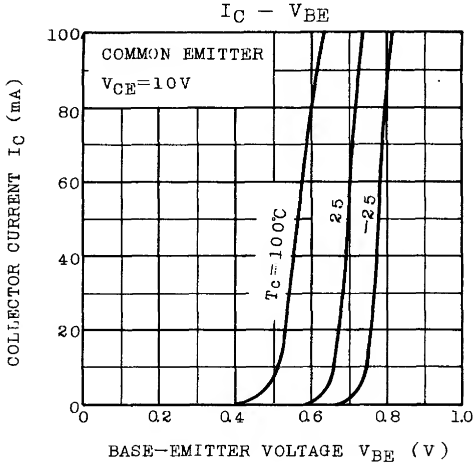
MAXIMUM RATINGS (Ta=25°C)

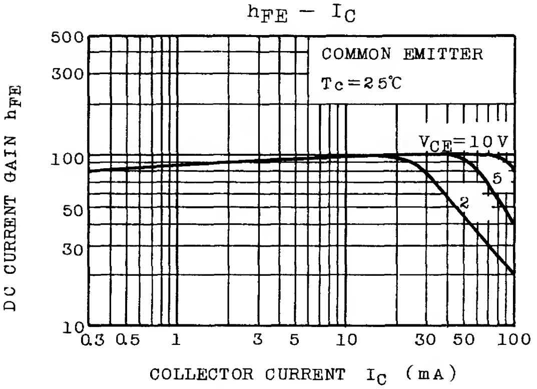
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	300	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	100	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

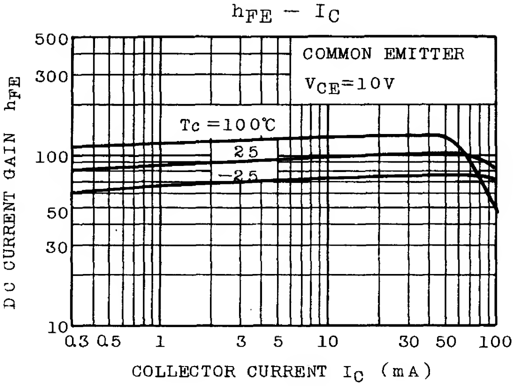
ELECTRICAL CHARACTERISTICS (Ta=25°C)

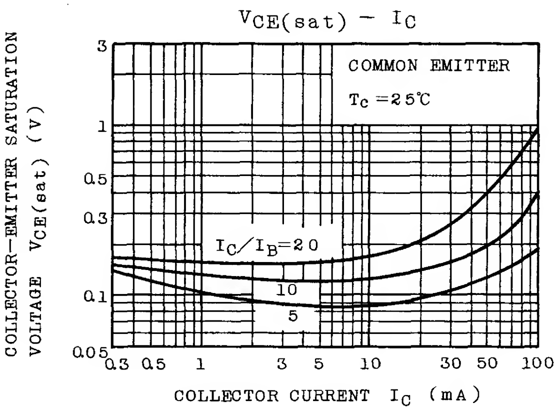
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=240V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=7V, I_C=0	-	-	1.0	μA
DC Current Gain	$h_{FE}(1)$	V_{CE}=10V, I_C=50mA	40	-	170	
	$h_{FE}(2)$	V_{CE}=10V, I_C=100mA	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=100mA, I_B=20mA	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=100mA, I_B=20mA	-	-	1.2	V
Transition Frequency	f_T	V_{CE}=10V, I_C=30mA	50	-	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	-	5.0	pF

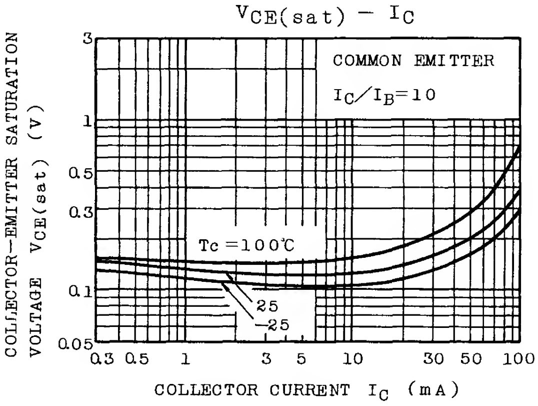

I_C - V_{CE}


I_C – V_{BE}

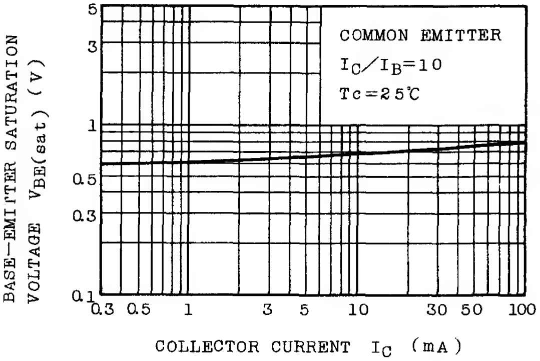

h_{FE} – I_C


h_{FE} – I_C

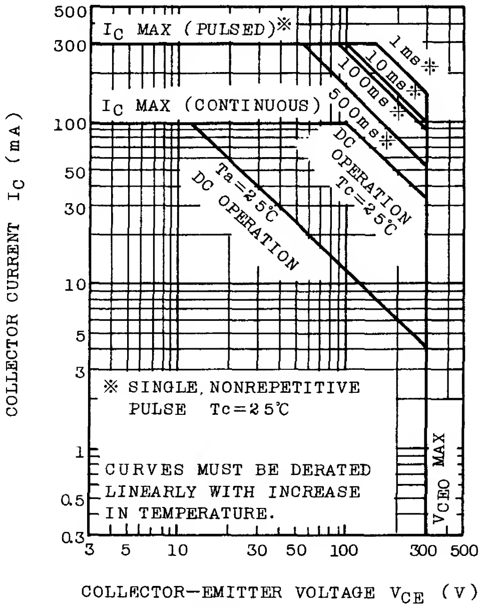

$V_{CE(sat)}$ – I_C


$V_{CE(sat)}$ – I_C

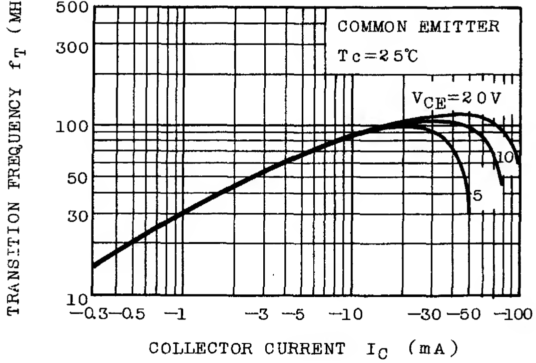
$V_{BE(sat)}$ — I_C



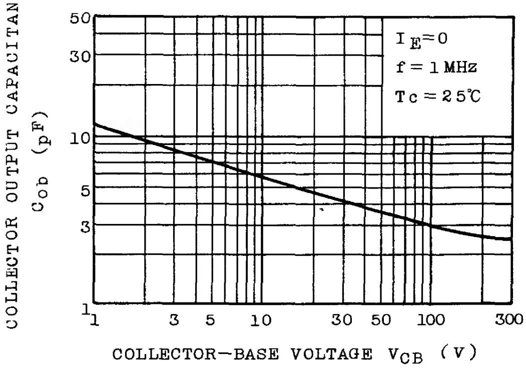
SAFE OPERATING AREA



f_T — I_C



C_{ob} — V_{CB}



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC2481

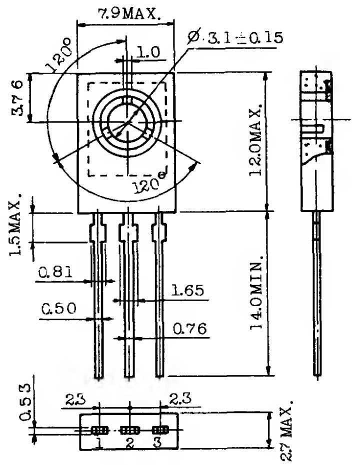
COLOR TV VERT. DEFLECTION OUTPUT APPLICATIONS.

COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability.
- Recommended for Vert. Deflection Output & Sound Output Applications for Line Operated TV.
- Complementary to 2SA1021

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

Mounting Kit No. AC46C

Weight : 0.72g

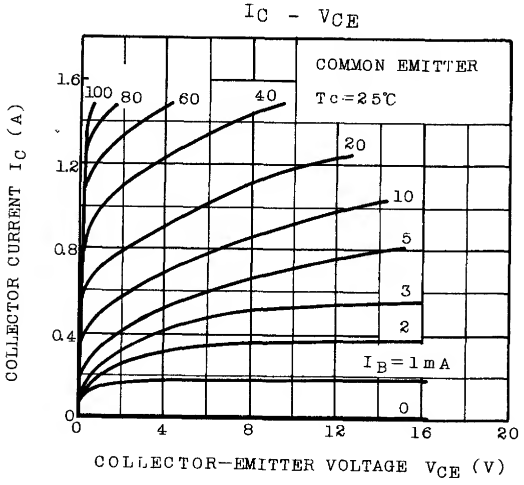
MAXIMUM RATINGS (Ta=25°C)

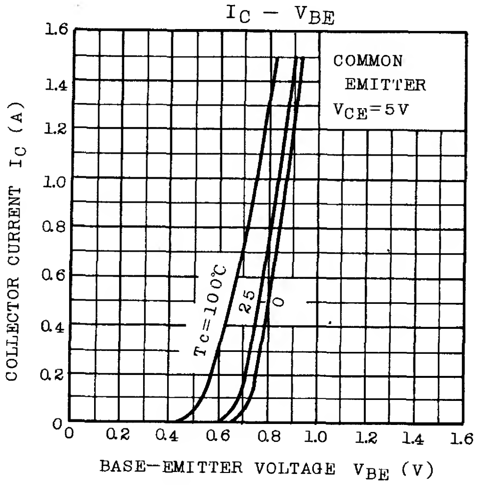
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	150	V
Collector-Emitter Voltage		V_{CEO}	150	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	1.5	A
Base Current		I_B	1.0	A
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

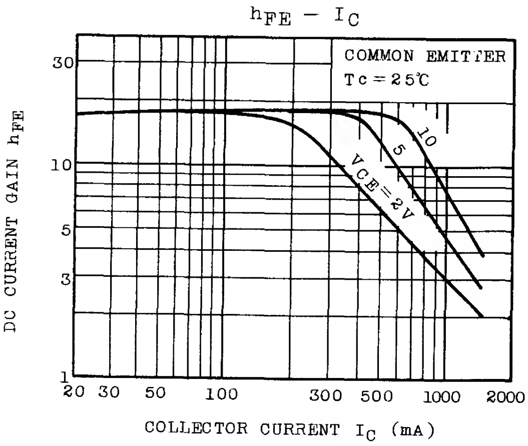
ELECTRICAL CHARACTERISTICS (Ta=25°C)

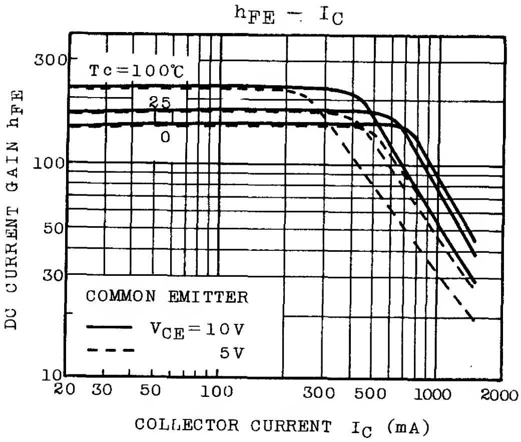
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=150V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	150	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=200mA	60	-	320	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5mA	0.5	-	0.8	V
Transition Frequency	f_T	V_{CE}=5V, I_C=200mA	20	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	13	20	pF

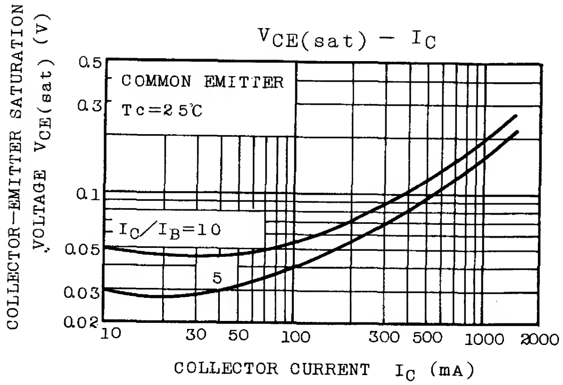
Note : h_{FE} Classification R:60~120 O:100~200 Y:160~320

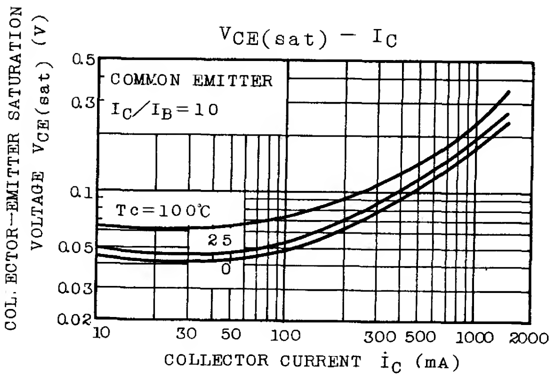

$I_C - V_{CE}$


$I_C - V_{BE}$

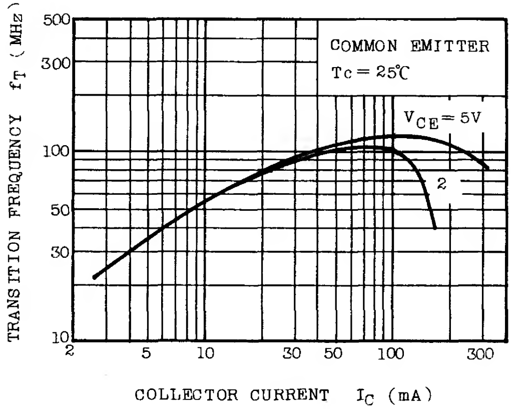

$h_{FE} - I_C$


$h_{FE} - I_C$

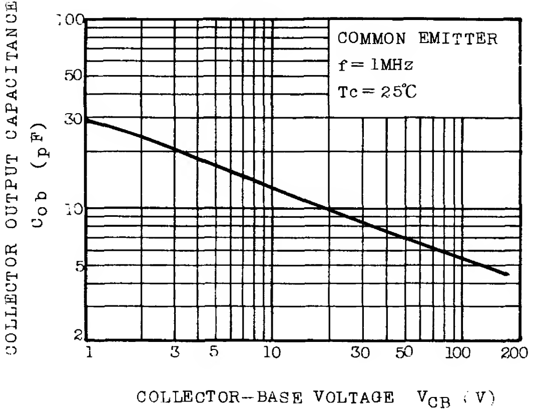

$V_{CE(sat)} - I_C$


$V_{CE(sat)} - I_C$

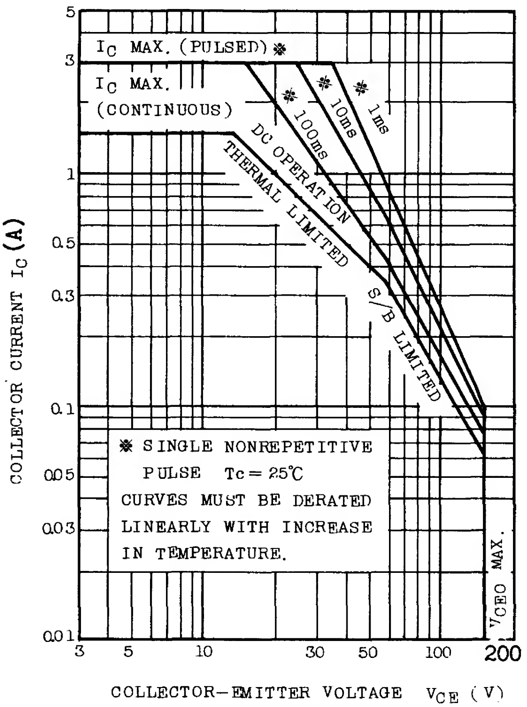
f_T – I_C



C_{ob} – V_{CB}



SAFE OPERATING AREA



2SC2483

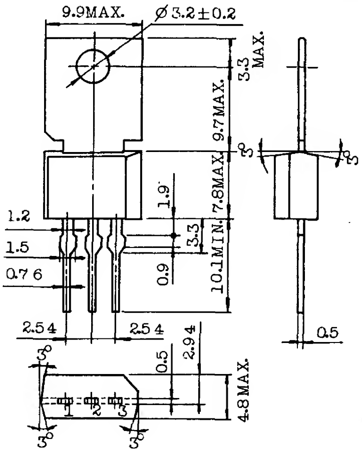
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.
COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability. (P_C=2.0W at Ta=25°C)
- Complementary to 2SA1195

Unit in mm



1. BASE
2. COLLECTOR
   (COLLECTOR CONNECTED TO TAB)
3. EMITTER

JEDEC	TO-202
EIAJ	-
TOSHIBA	2-10F1B

Weight : 1.4g

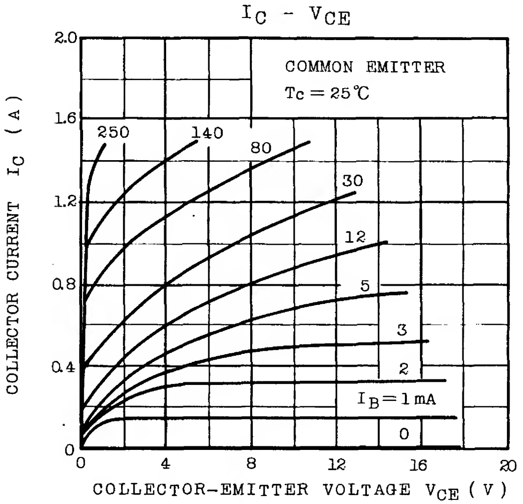
MAXIMUM RATINGS (Ta=25°C)

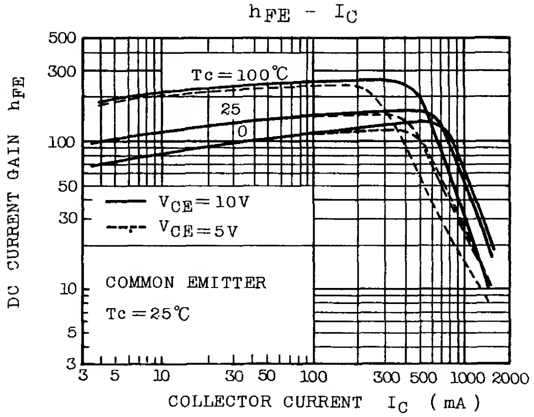
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	160	V
Collector-Emitter Voltage		V_{CEO}	160	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C	P_C	15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

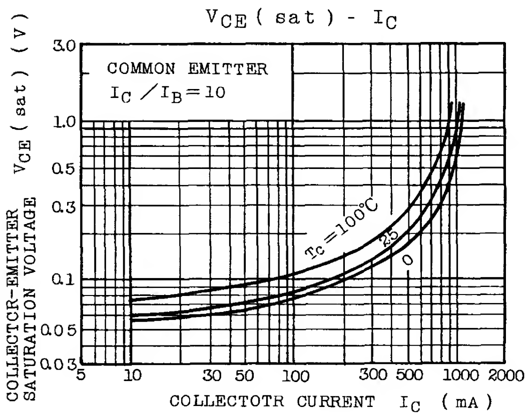
ELECTRICAL CHARACTERISTICS (Ta=25°C)

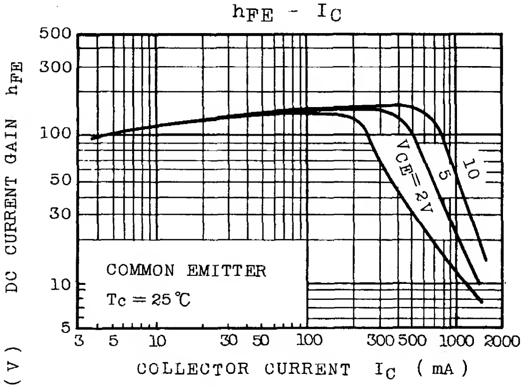
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=150V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	-	-	1.0	μA
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=200mA	100	-	320	
	$h_{FE(2)}$	V_{CE}=5V, I_C=500mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5mA	0.50	0.57	0.70	V
Transition Frequency	f_T	V_{CE}=5V, I_C=200mA	40	120	-	MHz
Collector Output Capacitance	Cob	VCB=10V, I_E=0, f=1MHz	-	-	20	pF

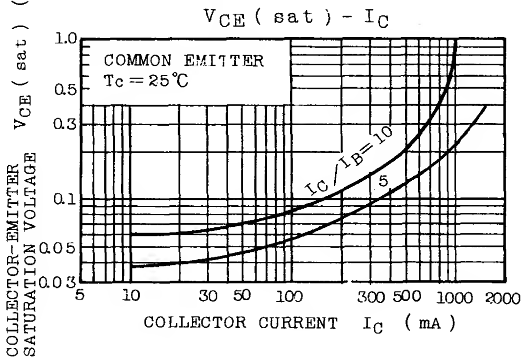
Note : $h_{FE(1)}$ Classification O : 100∿200, Y : 160∿320

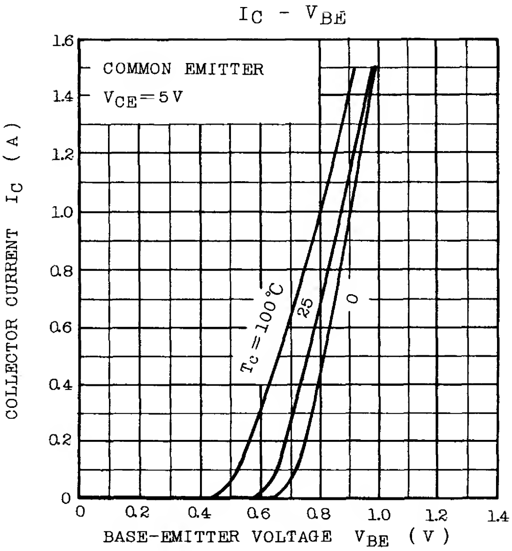

IC - VCE
COMMON EMITTER
Tc = 25℃
COLLECTOR CURRENT IC (A)
2.0
1.6
1.2
0.8
0.4
0
250
140
80
30
12
5
3
2
IB = 1 mA
0
4
8
12
16
20
COLLECTOR-EMITTER VOLTAGE VCE (V)


hFE - IC
DC CURRENT GAIN hFE
500
300
100
50
30
10
5
3
Tc = 100℃
25
0
VCE = 10V
VCE = 5V
COMMON EMITTER
Tc = 25℃
3
5
10
30
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)

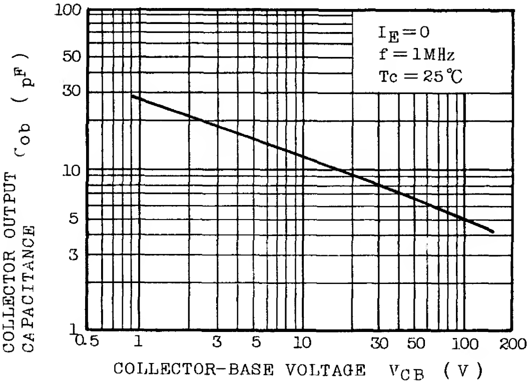

VCE (sat) - IC
COLLECTCR-EMITTER SATURATION VOLTAGE VCE (sat) (V)
COMMON EMITTER
IC / IB = 10
3.0
1.0
0.5
0.3
0.1
0.05
0.03
Tc = 100℃
25
0
5
10
30
50
100
300
500
1000
2000
COLLECTOTR CURRENT IC (mA)


hFE - IC
DC CURRENT GAIN hFE
500
300
100
50
30
10
5
VCE = 2V
5
10
COMMON EMITTER
Tc = 25℃
3
5
10
30
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)

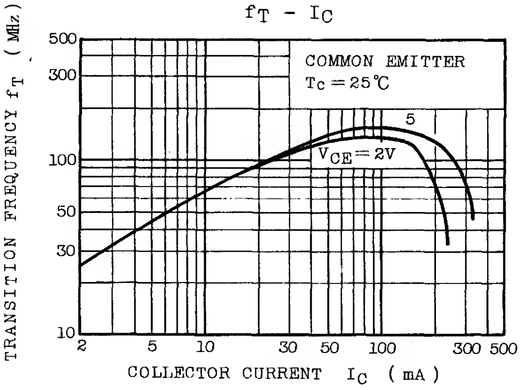

VCE (sat) - IC
COLLECTOR-EMITTER SATURATION VOLTAGE VCE (sat) (V)
COMMON EMITTER
Tc = 25℃
1.0
0.5
0.3
0.1
0.05
0.03
IC / IB = 10
5
5
10
30
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)


IC - VBE
COMMON EMITTER
VCE = 5 V
COLLECTOR CURRENT IC (A)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tc = 100℃
25
0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE-EMITTER VOLTAGE VBE (V)

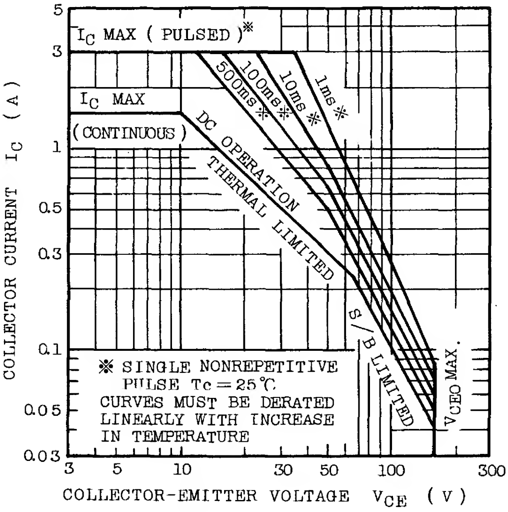
C_{ob} - V_{CB}



f_T - I_C



SAFE OPERATING AREA



SILICON NPN EPITAXIAL PLANAR TYPE

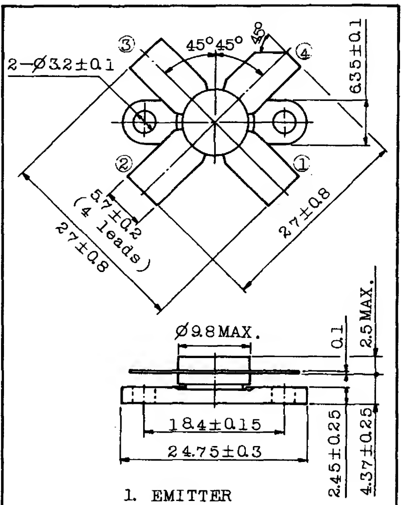
2SC2508

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=27W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=4.2W)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2-10H1A

Weight : 4.0g

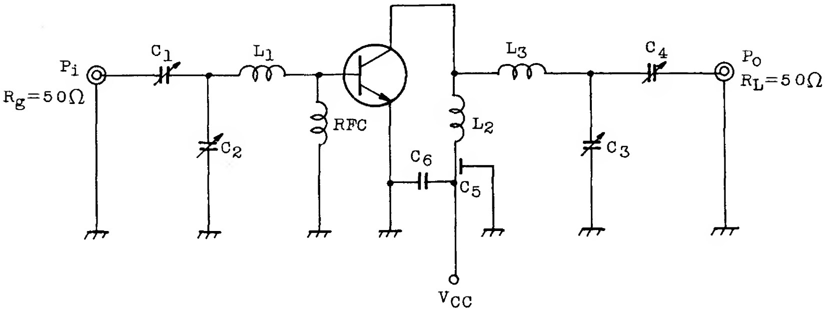
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25 °C)	P_C	50	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=3A	10	-	150	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=4.2W	27	29	-	W
Power Gain	G_{pe}		8.0	8.4	-	dB
Collector Efficiency	η_c		60	70	-	%

Fig. P_O TEST CIRCUIT



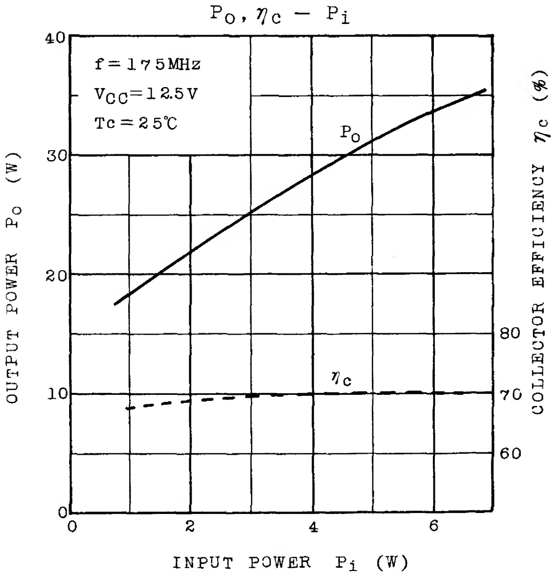
C_1 : ~20pF C_2, C_3, C_4 : ~30pF C_5 : 1000pF FEED THROUGH

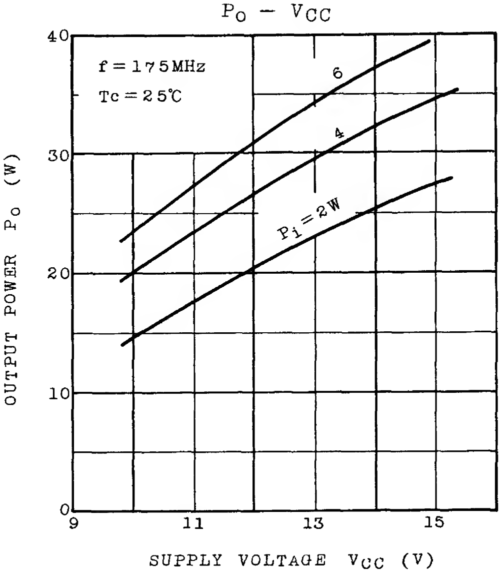
C_6 : 0.01μF

L_1, L_3 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 1T

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 2T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 8T



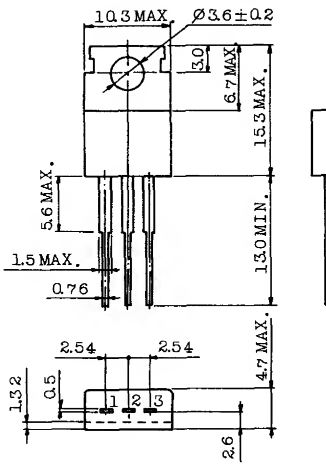


SILICON NPN EPITAXIAL PLANAR TYPE

2SC2509

2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1B

Weight : 1.9g

Mounting Kit No. AC75

FEATURES:

- Specified 12.5V, 28MHz Characteristics
  - : Output Power : P_O=10W_{PEP}
  - : Minimum Gain : G_{pe}=14dB
  - : Efficiency : η_c=35%(Min.)
  - : Intermodulation Distortion : IMD=-30dB(Max.)

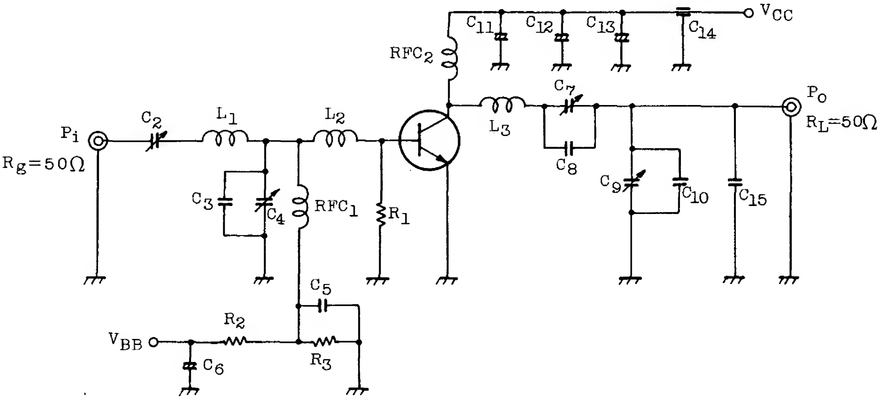
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	5	A
Collector Power Dissipation (Tc=25°C)	P_C	20	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55 ~150	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=50mA, V_{BE}=0	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	20	-	-	
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	200	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=12.5V, I_E=0, f=1MHz	-	-	150	pF
Power Gain	G_{pe}	V_{CC}=12.5V, f=28MHz 2-Tone, Δf=1kHz I_{idle}=30mA, P_O=10W_{PEP} (Fig.)	14.0	-	-	dB
Input Power	P_i		-	-	0.4	W_{PEP}
Collector Efficiency	η_c		35	-	-	%
Intermodulation Distortion	IMD		-	-	-30	dB

Fig. P_i TEST CIRCUIT



C_2, C_4, C_7 : 7 ~ 150pF

C_9 : 10 ~ 200pF

C_3 : 400pF

C_5, C_{13} : 0.4μF

C_6 : 10.0μF 10WV

C_8 : 400pF

C_{10} : 200pF

C_{11}, C_{12} : 22μF 35WV

C_{14} : 1000pF FEED THROUGH

L_1 : ϕ 0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T

L_2 : ϕ1 SILVER PLATED COPPER WIRE, 9ID, 2T

L_3 : ϕ1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T

RFC_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T

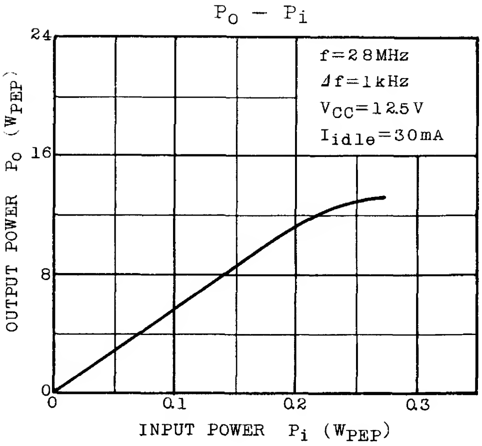
RFC_2 : ϕ1.5 ENAMEL COATED COPPER WIRE, 121ID, 15T

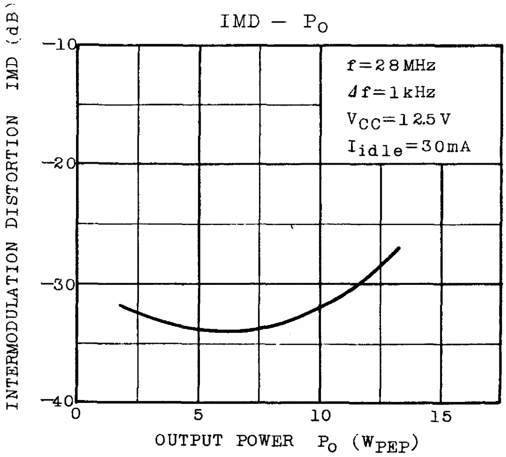
R_1 : 5.6Ω (1/2W)

R_2 : 5Ω (5W)

R_3 : 1.5Ω (10W)

C_{15} : 100pF





SILICON NPN EPITAXIAL PLANAR TYPE

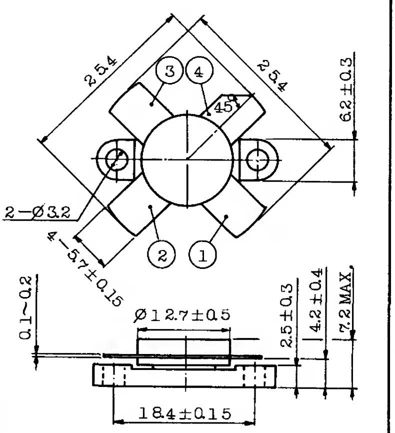
2SC2531

2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

FEATURES:

- Specified 28V, 28MHz Characteristics
  - : Output Power : P_O=150W_{PEP}
  - : Minimum Gain : Gpe=12.2dB
  - : Efficiency : η_c=35%(Min.)
  - : Intermodulation Distortion : IMD=−30dB(Max.)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−13B1A

Weight : 5.2g

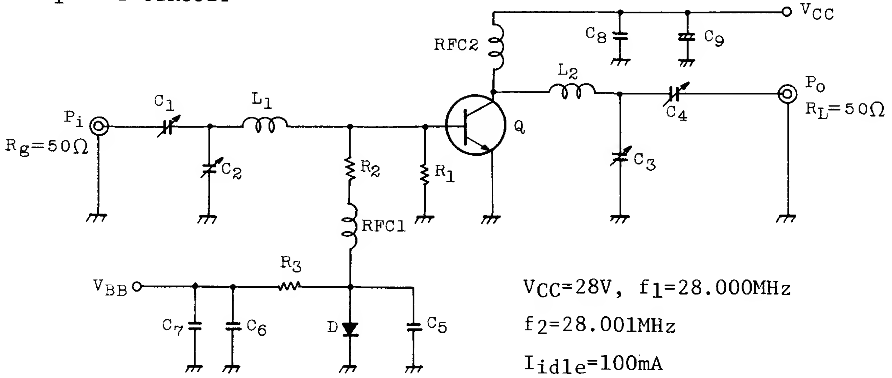
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation (Tc=25°C)	P_C	250	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	Tstg	−65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=100mA, V_{BE}=0	60	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=10A	10	-	-	
Collector Output Capacitance	Cob	V_{CB}=28V, I_E=0, f=1MHz	-	450	600	pF
Power Gain	Gpe	V_{CC}=28V, f=28MHz	12.2	13.3	-	dB
Input Power	P_i	2-Tone, Δf=1kHz	-	7	9	W_{PEP}
Collector Efficiency	η_c	Iidle=100mA, P_O=150W_{PEP}	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	−30	dB
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=28V, f=28MHz	-	1.4 −j0.9	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	Δf=1kHz, P_O=150W_{PEP}	-	2.3 −j0.9	-	Ω

Fig. P_i TEST CIRCUIT

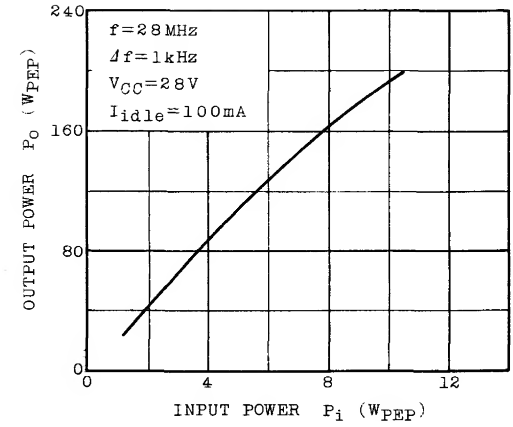


V_{CC}=28V, f_1=28.000MHz
f_2=28.001MHz
I_{idle}=100mA

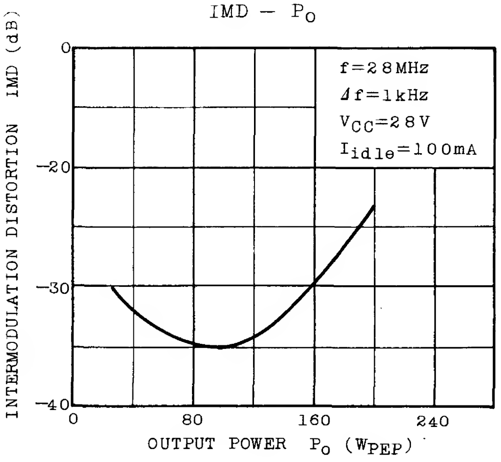
C_1,C_2 : 7～150pF
C_3,C_4 : 7～150pF 2KWV
C_5,C_6 : 0.022μF
C_7 : 47μF 10WV
C_8 : 0.04μF
C_9 : 100μF 50WV
Q : 2SC2510

L_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P
L_2 : ϕ1.2 ENAMEL COATED COPPER WIRE, 14ID, 3½T, 3P
RFC1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 10ID, 9T
(Ferrite Core TDK K2)
RFC2 : ϕ0.8 ENAMEL COATED COPPER WIRE, 14ID, 20T
R_1 : 10Ω(1W)
R_2 : 2Ω (1/2W)
R_3 : 10Ω(5W)
D : 1S1555

P_o − P_i



IMD − P_o



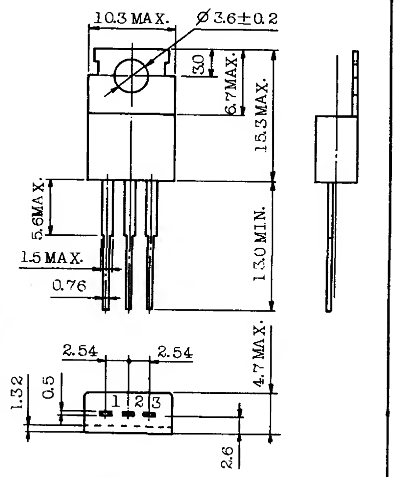
SILICON NPN TRIPLE DIFFUSED TYPE

2SC2552

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting kit No. AC75
Weight : 1.9g

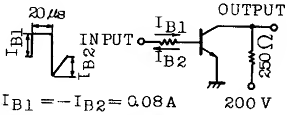
FEATURES:

- Excellent Switching Times
  : t_r=1.0μs (Max.) t_f=1.0μs (Max.) at I_C=0.8A
- High Collector Breakdown Voltage : V_{CEO}=400V

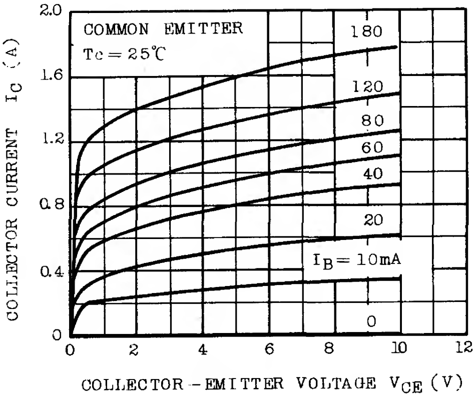
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

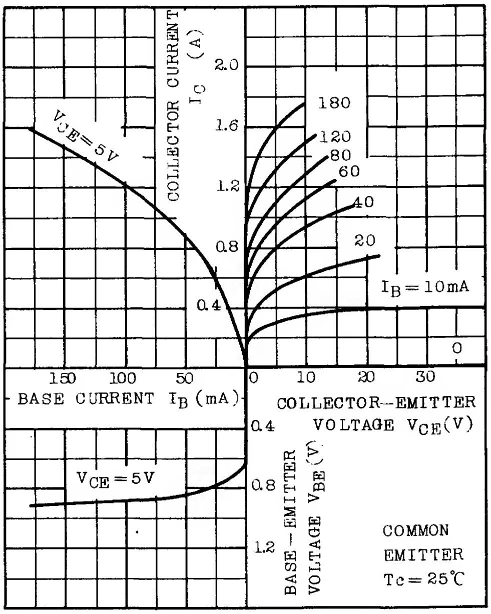
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	
			V_{CE}=5V, I_C=1A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 250Ω 200 V I_{B1} = $-I_{B2}$ = 0.08A DUTY CYCLE<1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

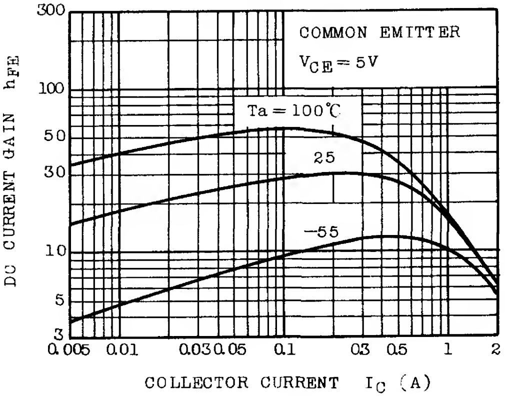
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



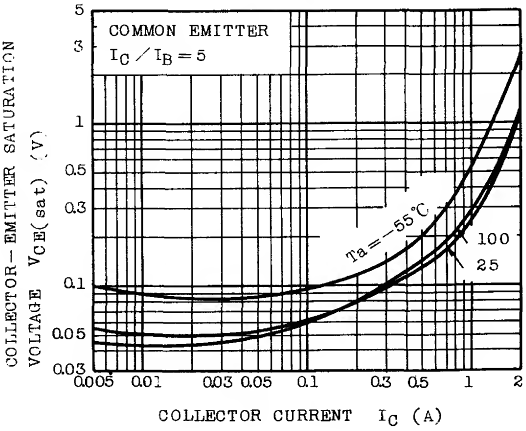
STATIC CHARACTERISTICS



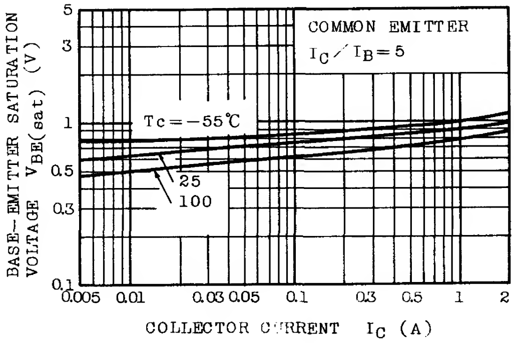
$h_{FE} - I_C$

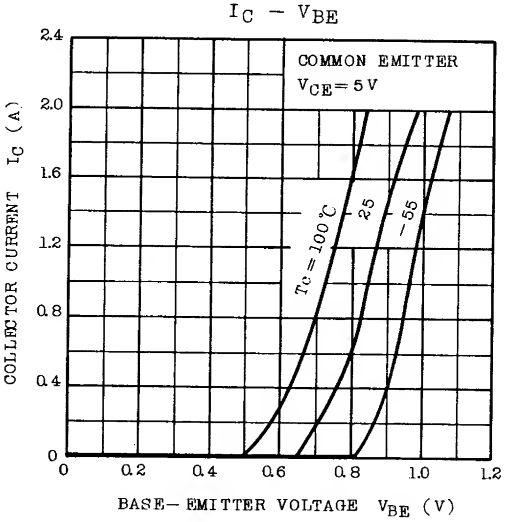


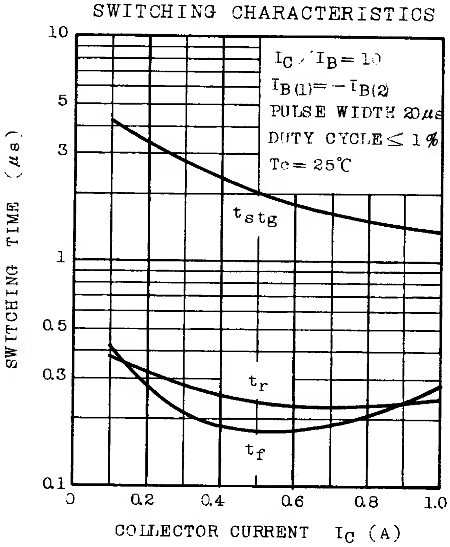
$V_{CE(sat)} - I_C$

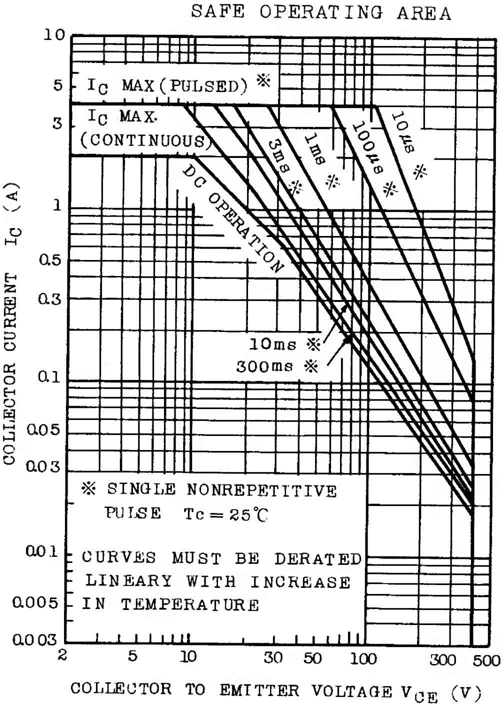


$V_{BE(sat)} - I_C$




IC − VBE
COMMON EMITTER
VCE = 5 V
Tc = 100°C
25
−55
COLLECTOR CURRENT IC (A)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
0.2
0.4
0.6
0.8
1.0
1.2
BASE−EMITTER VOLTAGE VBE (V)


SWITCHING CHARACTERISTICS
IC / IB = 10
IB(1) = −IB(2)
PULSE WIDTH 20 μs
DUTY CYCLE ≤ 1 %
Tc = 25°C
tstg
tr
tf
SWITCHING TIME (μs)
10
5
3
1
0.5
0.3
0.1
0
0.2
0.4
0.6
0.8
1.0
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
IC MAX (PULSED) ※
IC MAX. (CONTINUOUS)
DC OPERATION
3ms ※
1ms ※
100μs ※
10μs ※
10ms ※
300ms ※
※ SINGLE NONREPETITIVE PULSE Tc = 25°C
CURVES MUST BE DERATED LINEARY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.005
0.003
2
5
10
30
50
100
300
500
COLLECTOR TO EMITTER VOLTAGE VCE (V)

2SC2553

SILICON NPN TRIPLE DIFFUSED TYPE

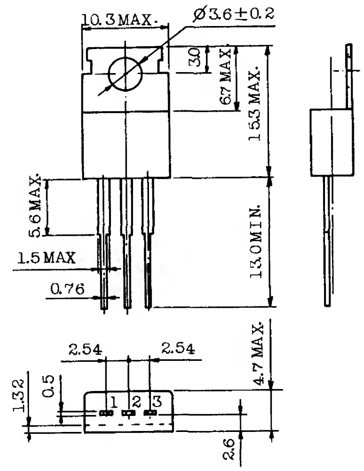
INDUSTRIAL APPLICATIONS

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
  : t_r=1.0µs(Max.), t_f=1.0µs(Max.) at I_C=4A
- High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

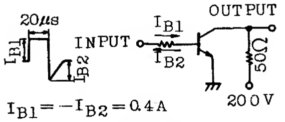
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting kit No. AC75
Weight :1.9g

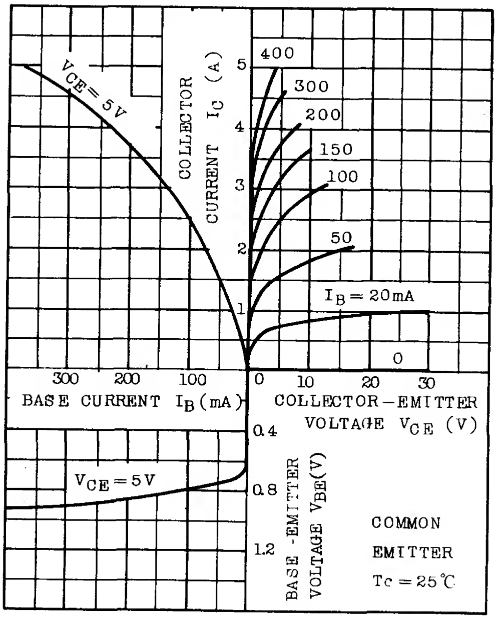
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	5	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

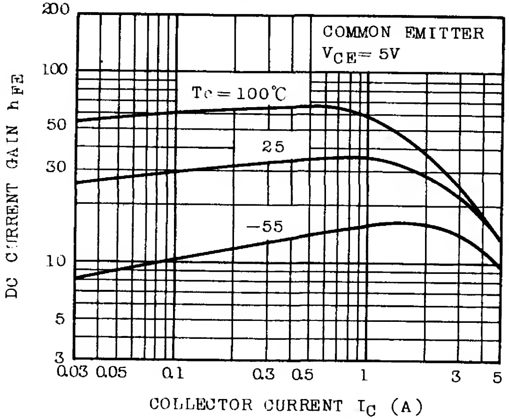
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	A
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=3A	12	-	-	
			V_{CE}=5V, I_C=5A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20µs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 50Ω 200V $I_{B1}=-I_{B2}$=0.4A DUTY CYCLE<1%	-	-	1.0	µs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

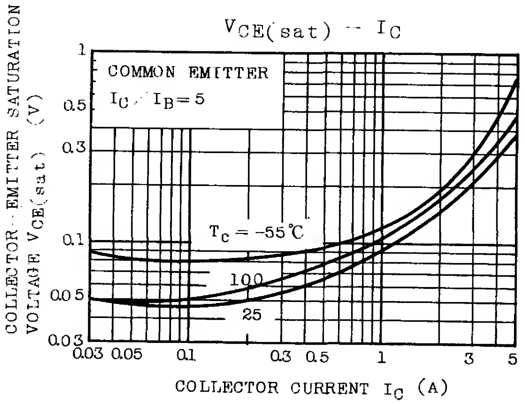
STATIC CHARACTERISTICS



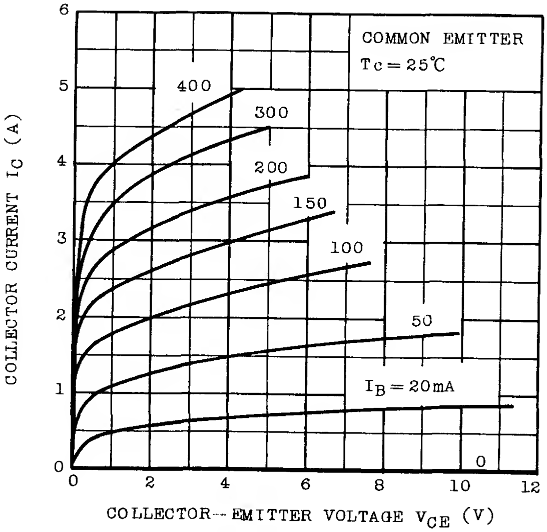
h_{FE} − I_C



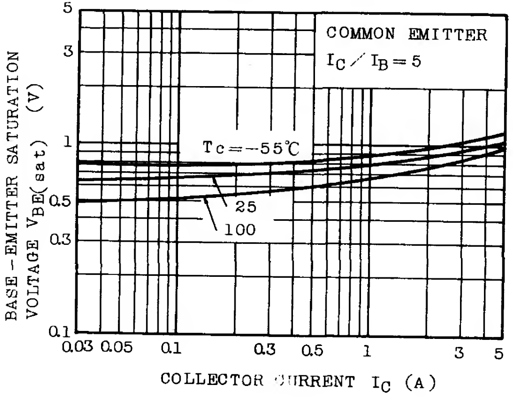
$V_{CE(sat)}$ − I_C



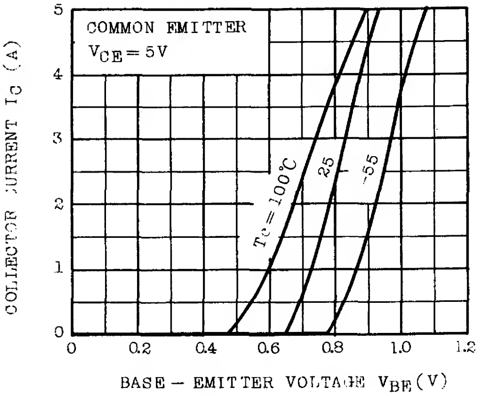
I_C − V_{CE} (LOW VOLTAGE REGION)



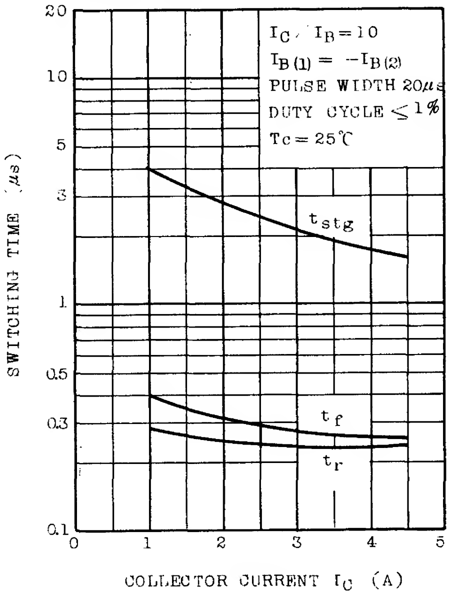
$V_{BE(sat)}$ − I_C



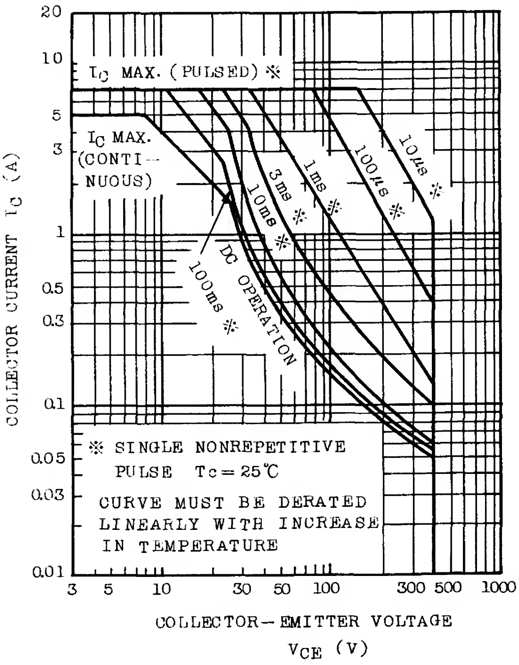
IC − VBE



SWITCHING CHARACTERISTICS



SAFE OPERATING AREA

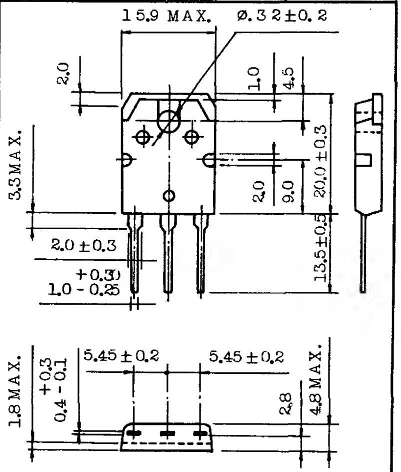


SILICON NPN TRIPLE DIFFUSED TYPE

2SC2555

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2—16B1A

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

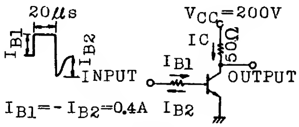
- Escellent Switching Times
  : t_r=1.0 μs (Max.) , t_f=1.0 μs (Max.) at I_C=4A
- High Collector Breakdown Voltage : V_{CEO}=400V

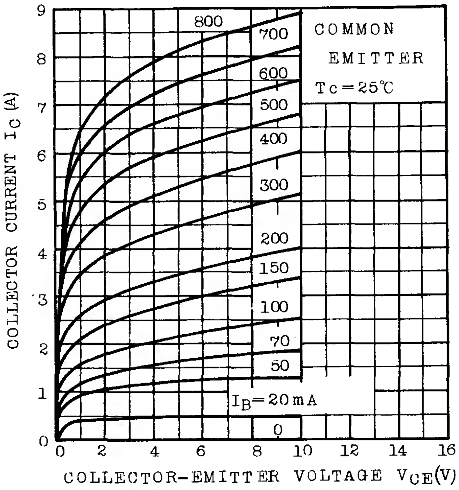
MAXIMUM RATINGS (Ta=25℃)

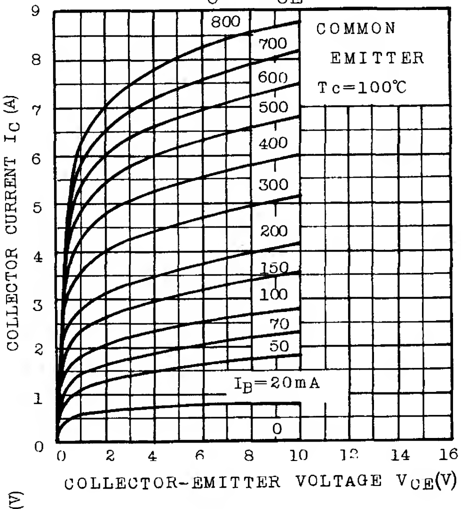
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	8	A
Base Current		I_B	4	A
Collector Power Dissipation	Ta=25 ℃	P_C	2.5	W
	Tc=25 ℃		80	
Junction Temperature		T_j	150	℃
Storage Temperature Range		T_{stg}	-55～150	℃

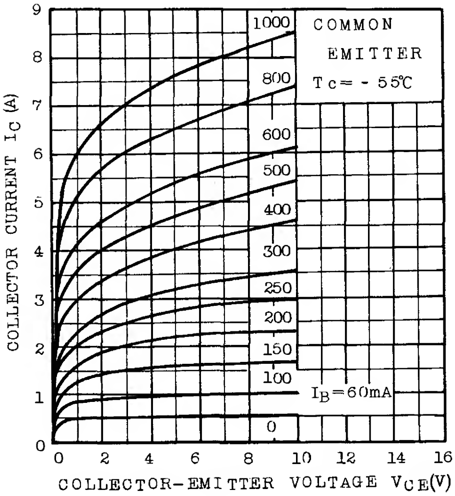
Weight : 4.6g

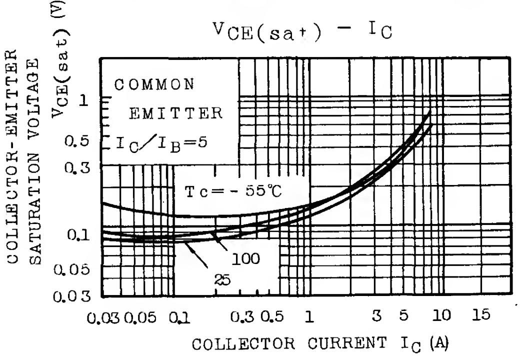
ELECTRICAL CHARACTERISTICS (Ta=25℃)

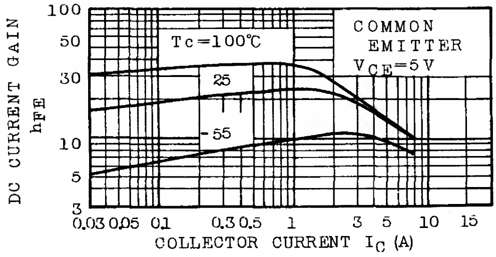
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	—	—	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	—	—	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	—	—	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	—	—	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=1A	15	—	—	
		$h_{FE(2)}$	V_{CE}=5V, I_C=4A	10	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.8A	—	—	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.8A	—	—	1.5	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} INPUT V_{CC}=200V IC 50Ω I_{B1} OUTPUT I_{B2} I_{B1}=-I_{B2}=0.4A DUTY CYCLE ≦ 1%	—	—	1.0	μs
	Stotage Time	t_{stg}		—	—	2.5	
	Fall Time	t_f		—	—	1.0	

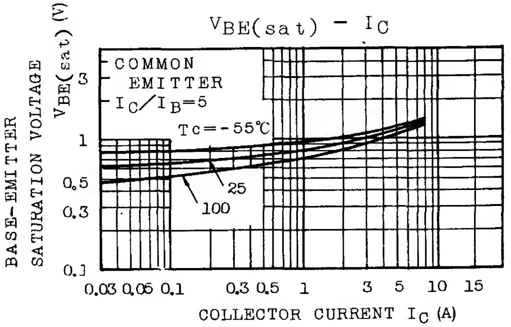

IC – VCE

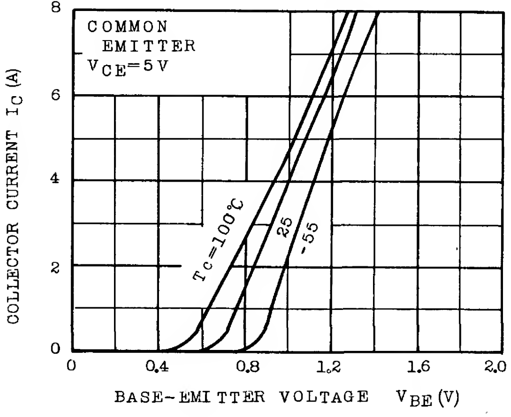

IC – VCE


IC – VCE

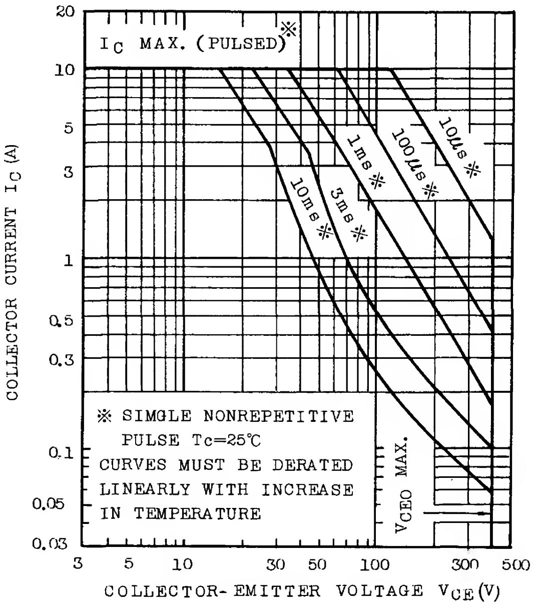

VCE(sat) – IC


hFE – IC

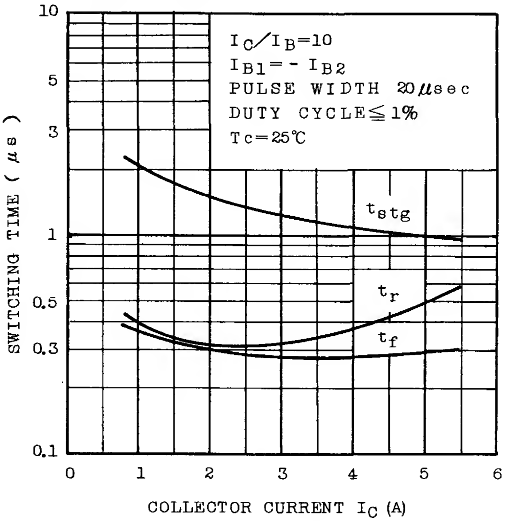

VBE(sat) – IC



$I_C - V_{BE}$



SAFE OPERATING AREA



SWITCHING CHARACTERISTICS

2SC2562

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

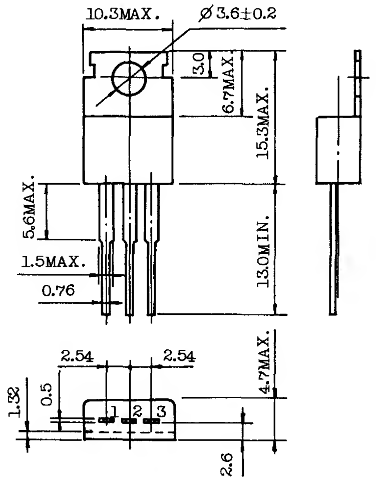
INDUSTRIAL APPLICATIONS

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage :
  $V_{CE(sat)}$=0.4V (Max.) (at I_C=3A)
- High Speed Switching Time : t_{stg}=1.0µs (Typ.)
- Complementary to 2SA1012.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

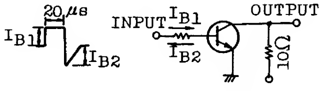
JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

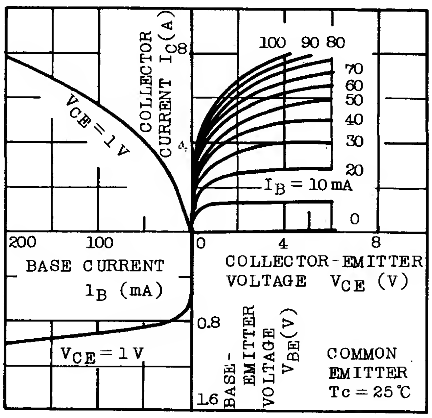
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

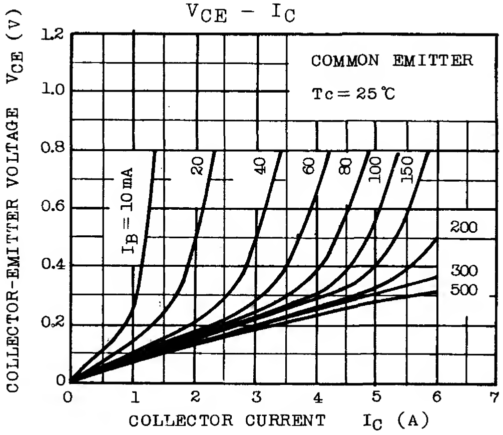
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	1	µA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	µA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=3A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=0.15A	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=3A, I_B=0.15A	-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	120	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 20µs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω V_{CC} = 30V I_{B1}=−I_{B2}=0.15A DUTY CYCLE≦1%	-	0.1	-	µs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

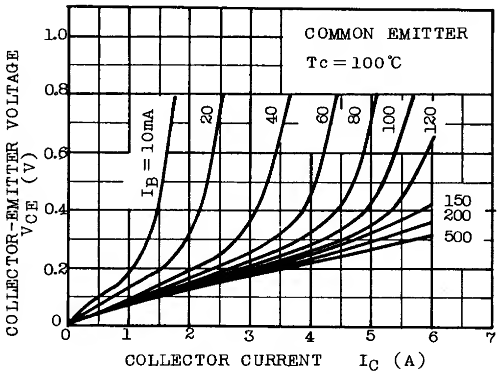
STATIC CHARACTERISTICS



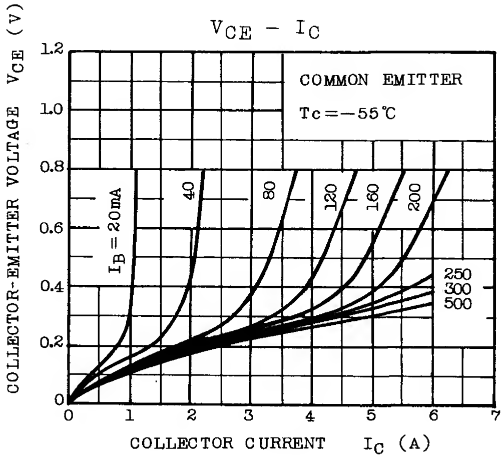
V_{CE} – I_C



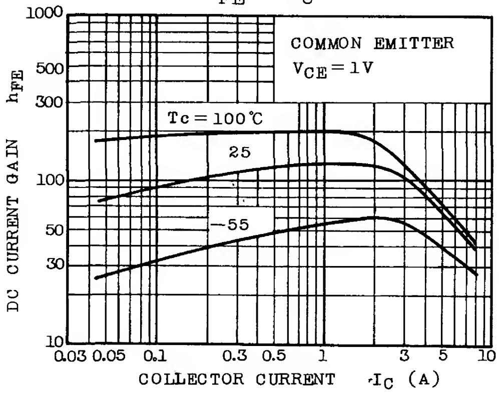
V_{CE} – I_C



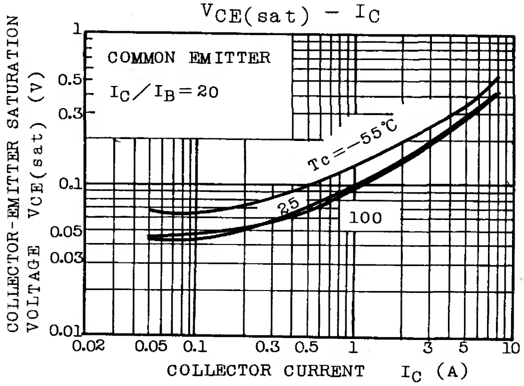
V_{CE} – I_C



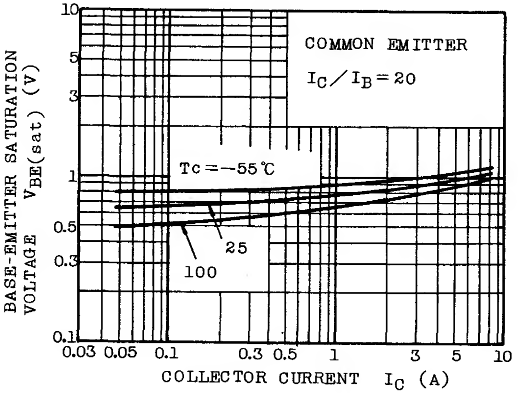
h_{FE} – I_C



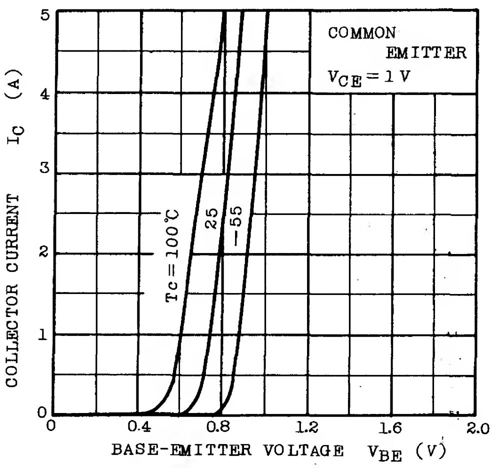
$V_{CE(sat)}$ – I_C



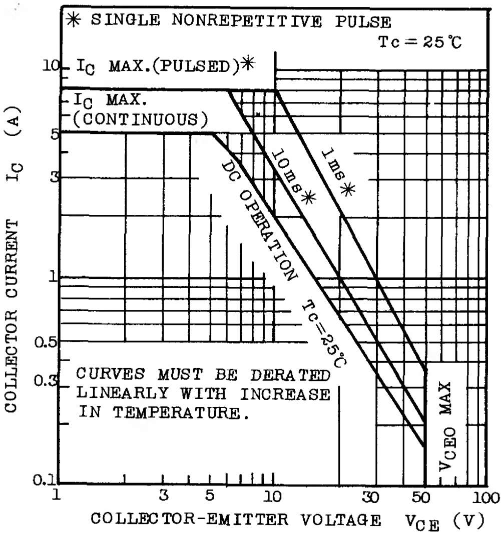
$V_{BE(sat)}$ – I_C



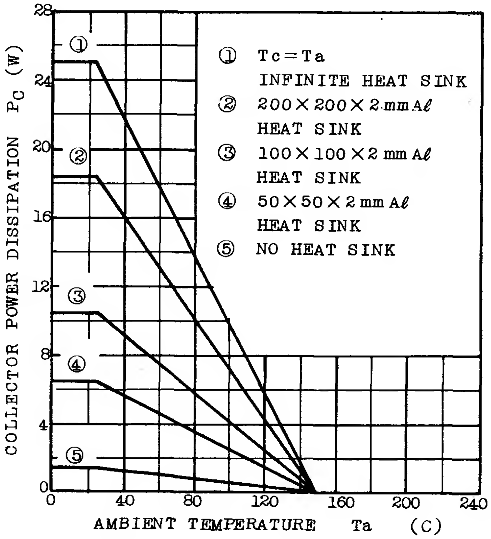
I_C – V_{BE}



SAFE OPERATING AREA



P_C – Ta



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

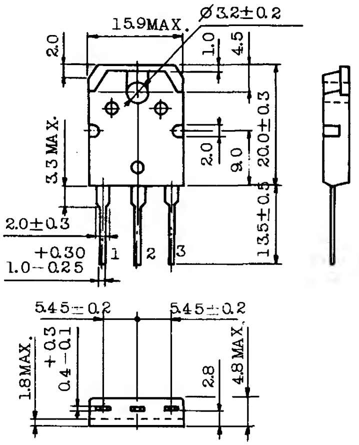
2SC2563

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SA1093.
- . Recommended for 50W audio amplifier output stage.
- . High transition frequency : f_T=90MHz(Typ.)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

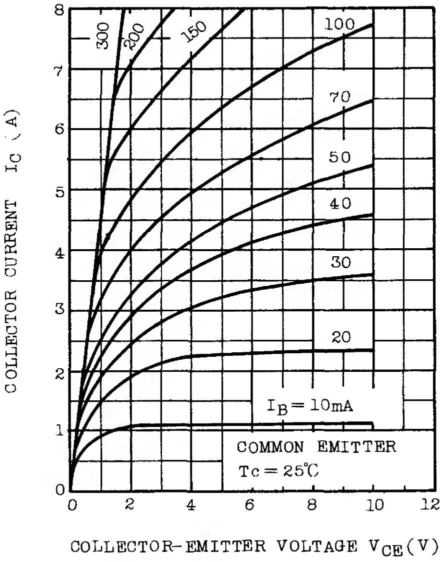
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	120	V
Collector-Emitter Voltage	V_{CEO}	120	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	8	A
Base Current	I_B	0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

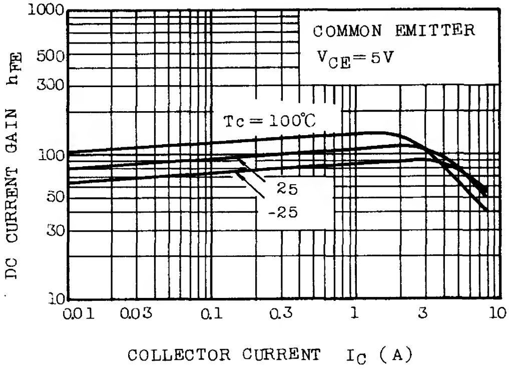
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=120V, I_E=0	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=0.05A, I_B=0	120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=4A	30	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	1.0	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=4A	-	1.5	2.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	90	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	90	-	pF

Note: h_{FE} Classification. R:55~110, O:80~160, Y:120~240

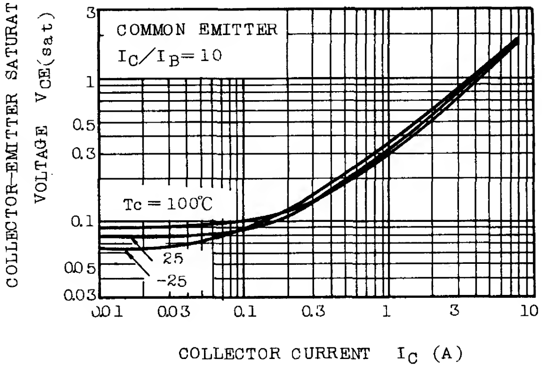
$I_C - V_{CE}$



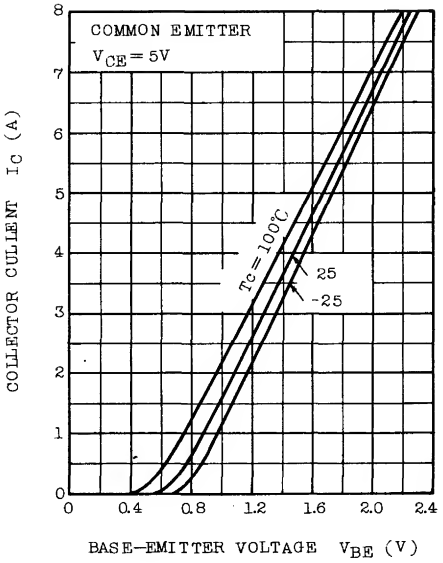
$h_{FE} - I_C$



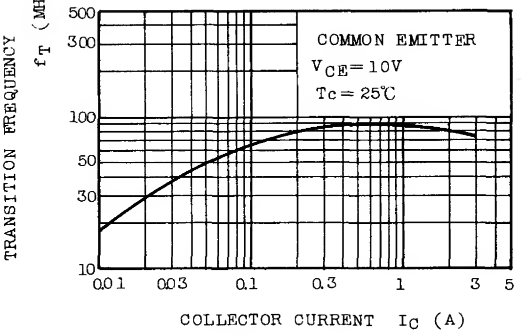
$V_{CE(sat)} - I_C$

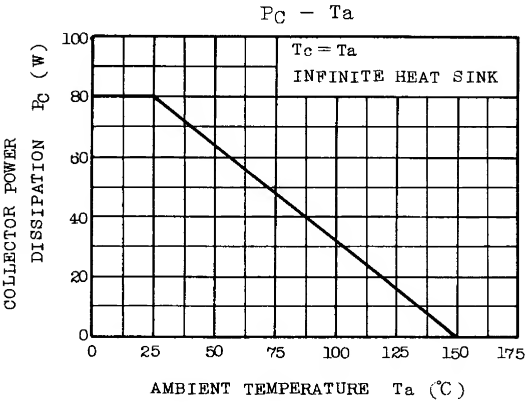


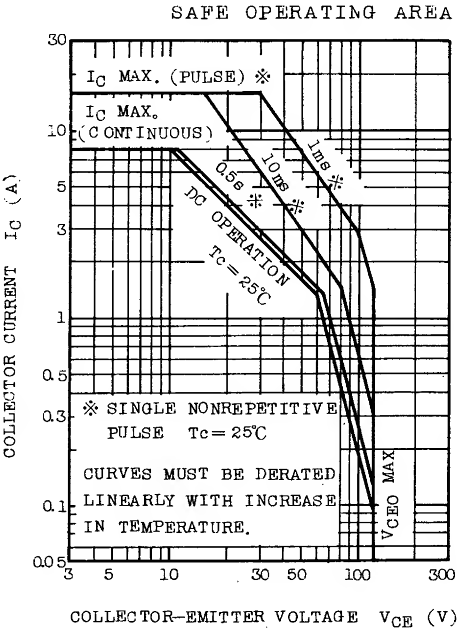
$I_C - V_{BE}$



$f_T - I_C$




PC − Ta
Tc = Ta
INFINITE HEAT SINK
COLLECTOR POWER DISSIPATION PC (W)
100
80
60
40
20
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX. (PULSE) ※
IC MAX. (CONTINUOUS)
1ms ※
10ms ※
0.5s ※
DC OPERATION Tc = 25℃
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX
COLLECTOR CURRENT IC (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
3
5
10
30
50
100
300
COLLECTOR-EMITTER VOLTAGE VCE (V)

2SC2564

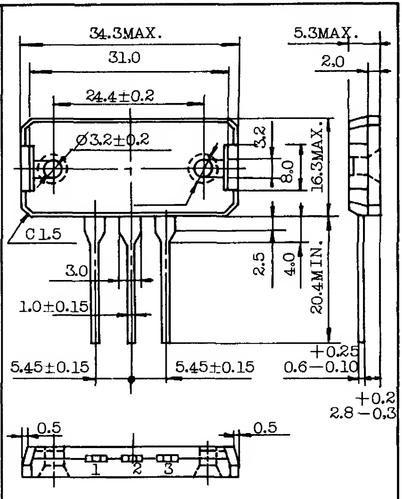
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=140V
- High Transition Frequency : f_T=90MHz (Typ.)
- Complementary to 2SA1094.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 34A1A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

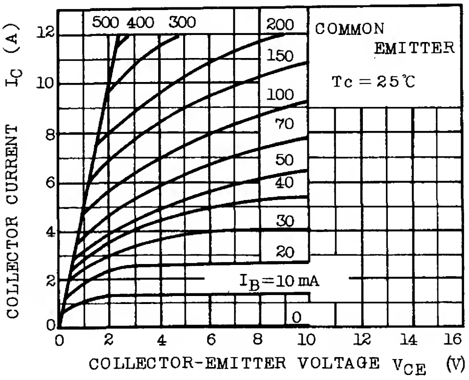
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	140	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	12	A
Emitter Current	I_E	-12	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

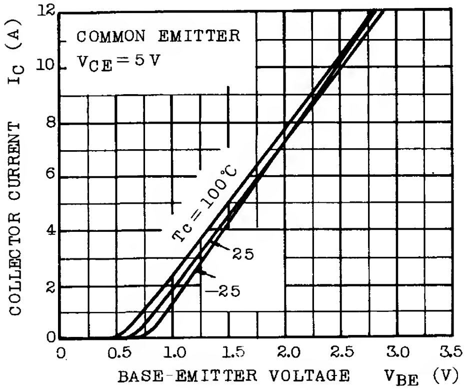
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=140V, I_E=0	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=0.1A, I_B=0	140	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.01A, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=5A	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	-	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	90	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	130	-	pF

Note : $h_{FE}(1)$ Classification R : 55∿110, O : 80∿160, Y : 120∿240

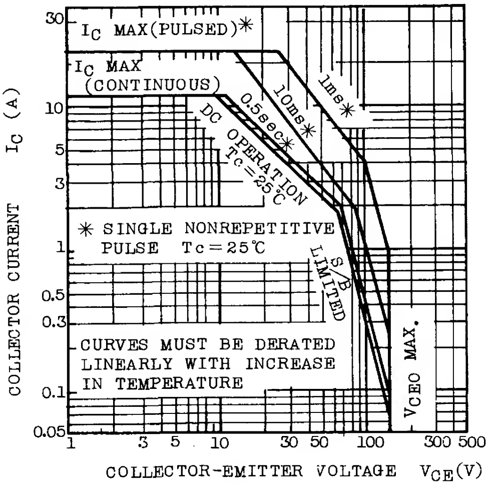
$I_C - V_{CE}$



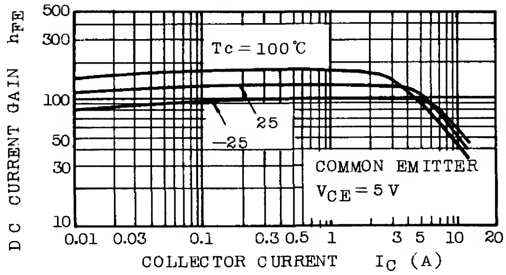
$I_C - V_{BE}$



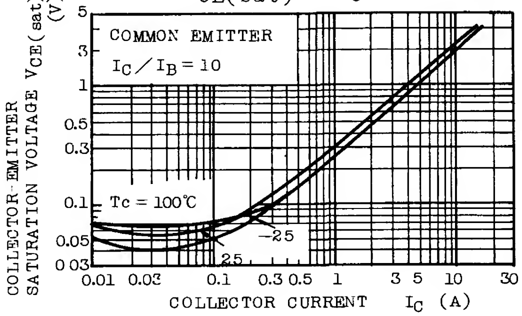
SAFE OPERATING AREA



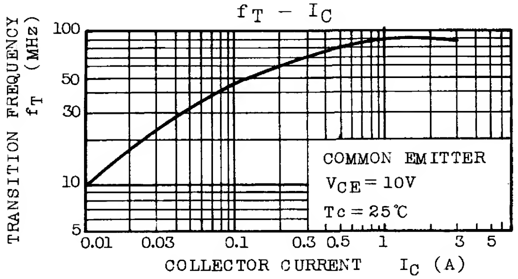
$h_{FE} - I_C$



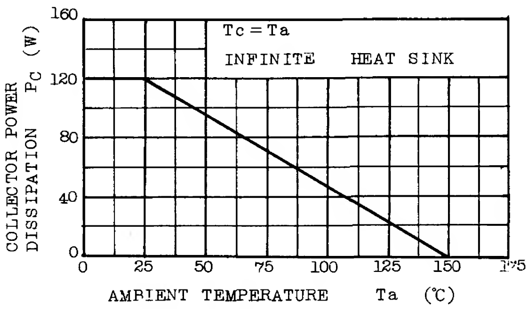
$V_{CE(sat)} - I_C$



$f_T - I_C$



$P_C - Ta$



2SC2565

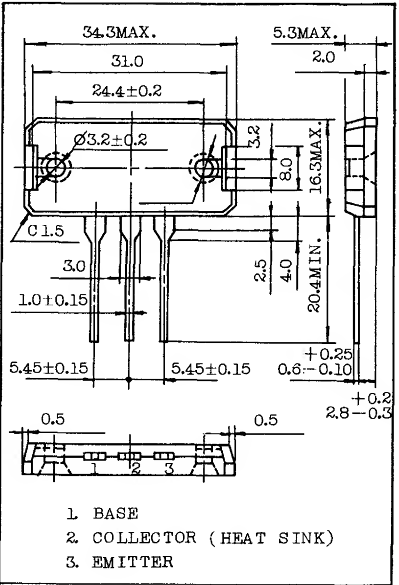
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=160V
- High Transition Frequency : f_T=80MHz (Typ.)
- Complementary to 2SA1095.
- Recommended for 100W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 − 34A1A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

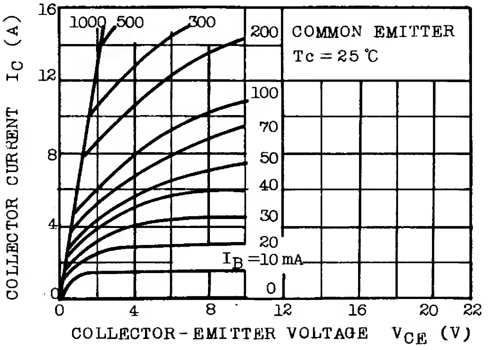
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	160	V
Collector-Emitter Voltage	V_{CEO}	160	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Emitter Current	I_E	-15	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

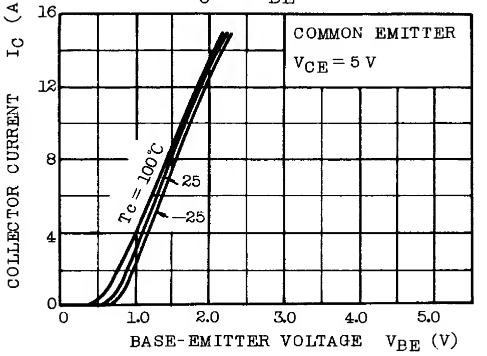
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=160V, I_E=0	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=0.1A, I_B=0	160	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.01A, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=5A	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	-	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	80	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	200	-	pF

Note : $h_{FE(1)}$ Classificaiton R : 55∿110, O : 80∿160, Y : 120∿240

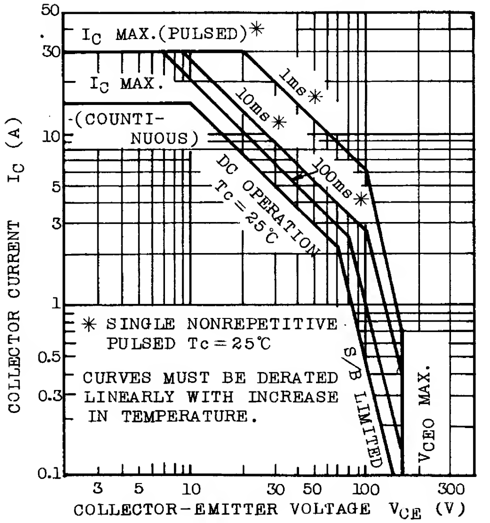
$I_C - V_{CE}$



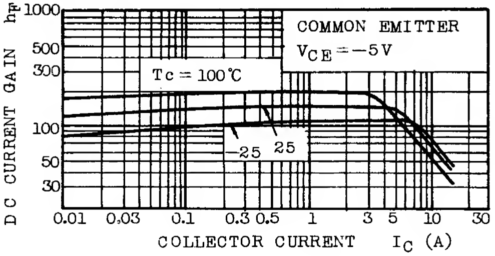
$I_C - V_{BE}$



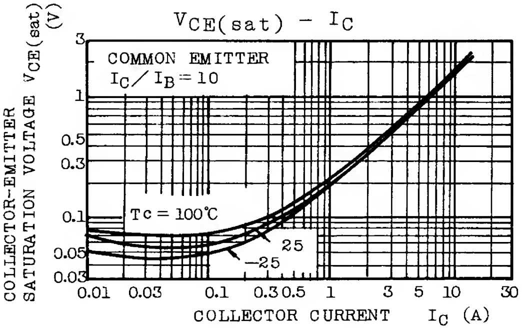
SAFE OPERATING AREA



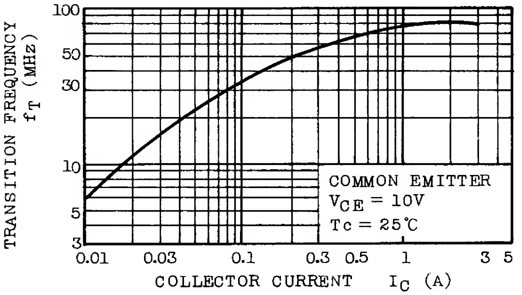
$h_{FE} - I_C$



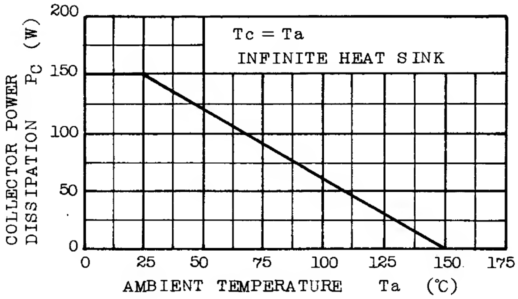
$V_{CE(sat)} - I_C$



$f_T - I_C$



$P_C - Ta$



2SC2638

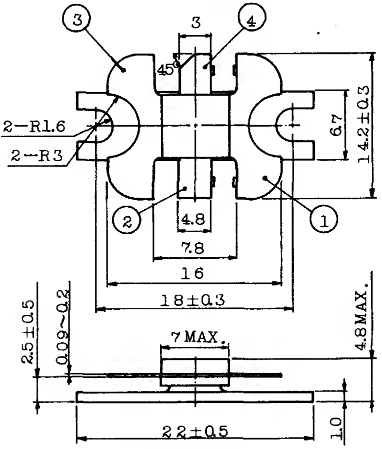
SILICON NPN EPITAXIAL PLANAR TYPE

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_o=6W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=0.5W)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−7A1A

Weight : 1.6g

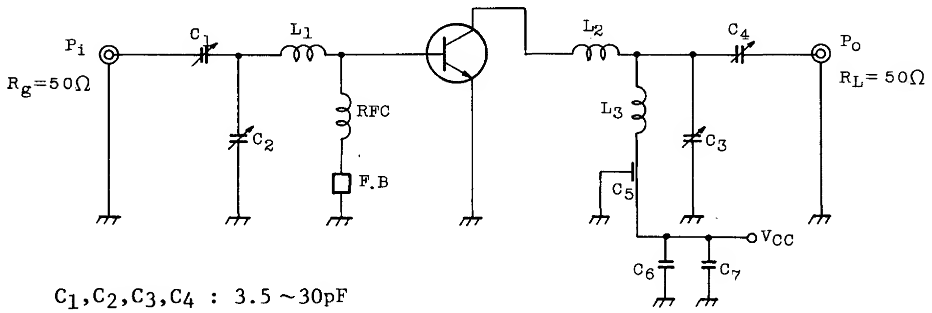
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	−65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	25	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=0.5W	6	7	-	W
Power Gain	G_{pe}		10.7	11.5	-	dB
Collector Efficiency	η_c		60	72	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=6W	-	3.5 +j4.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	10 −j1.5	-	Ω

Fig. P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : 3.5 ~30pF

C_5 : 0.01μF FEED THROUGH

C_6 : 0.033μF CERAMIC CONDENSER

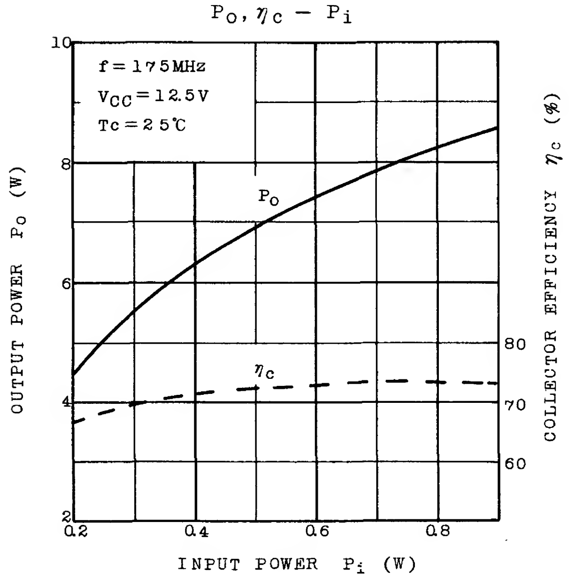
C_7 : 10μF

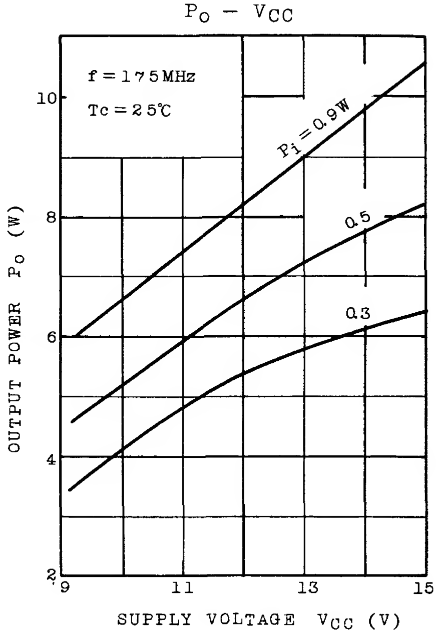
L_1, L_2 : ϕ1 SILVER PLATED COPPER WIRE, 12ID, 1T

L_3 : ϕ1 SILVER PLATED COPPER WIRE, 12ID, 2T

RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T

FB : FERRITE BEADS





2SC2639

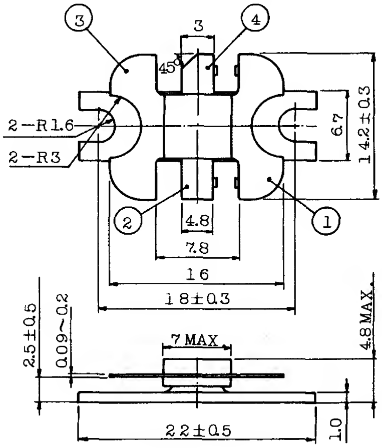
SILICON NPN EPITAXIAL PLANAR TYPE

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=15W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=1.3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.5V, P_i=1.3W, f=175MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−7A1A

Weight : 1.6g

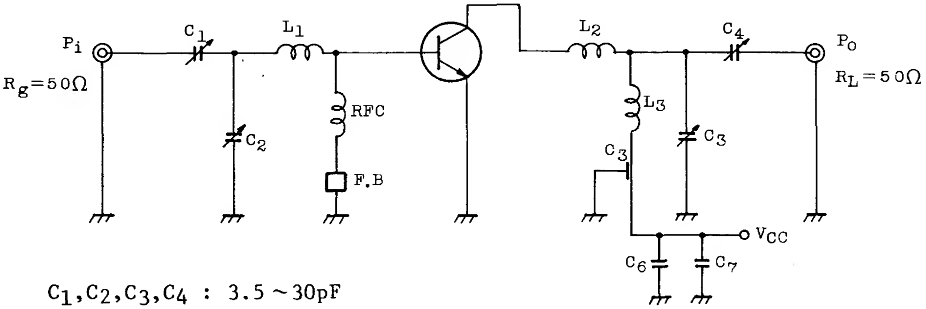
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	35	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=1.3W	15	17	-	W
Power Gain	G_{pe}		10.6	11.2	-	dB
Collector Efficiency	η_c		60	75	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=15W	-	1.5 -j2.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.0 -j1.0	-	Ω

Fig. P_o TEST CIRCUIT



C_1,C_2,C_3,C_4 : 3.5～30pF

C_5 : 0.01μF FEED THROUGH

C_6 : 0.033μF CERAMIC CONDENSER

C_7 : 10μF

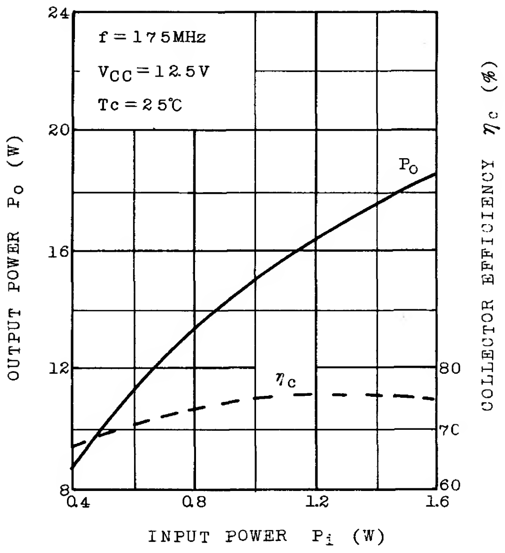
L_1,L_2 : ϕ1 SILVER PLATED COPPER WIRE, 12ID, 1T

L_3 : ϕ1 SILVER PLATED COPPER WIRE, 12ID, 2T

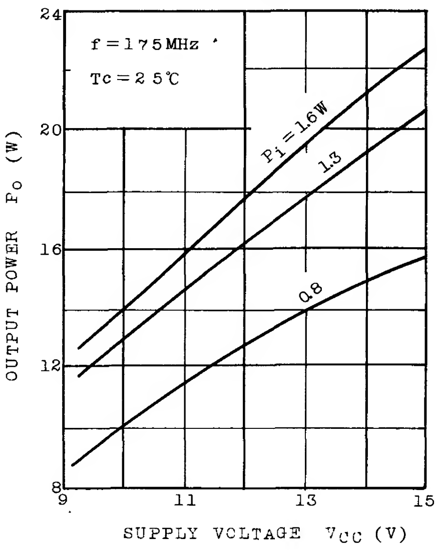
RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T

FB : FERRITE BEADS

$P_o, \eta_c - P_i$



$P_o - V_{CC}$



2SC2640

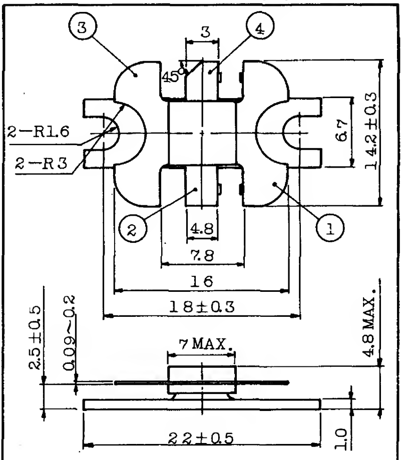
SILICON NPN EPITAXIAL PLANAR TYPE

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : P_O=28W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=4W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=14.5V, P_i=4W, f=175MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2−7A1A

Weight : 1.6g

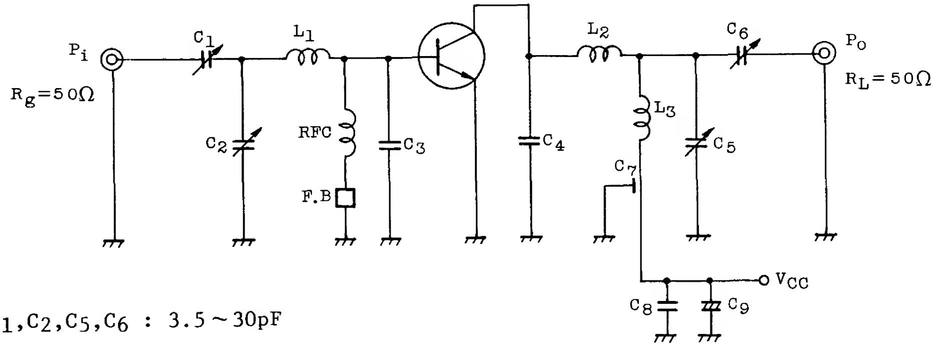
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	70	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	−65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

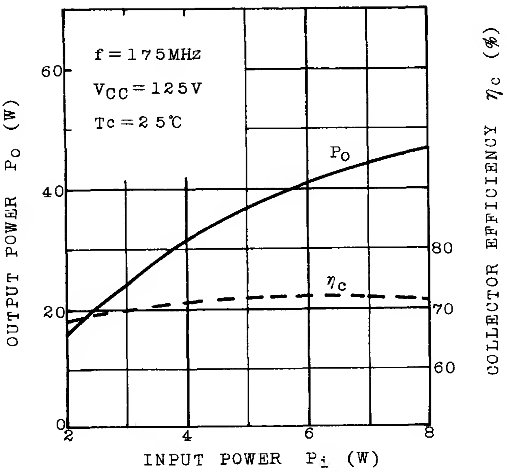
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	−	−	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	40	−	−	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	17	−	−	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	−	−	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=5A	10	−	−	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	110	160	pF
Output Power	P_o	(Fig.) V_{CC}=12.5V, f=175MHz, P_i=4W	28	31	−	W
Power Gain	G_{pe}		8.4	8.9	−	dB
Collector Efficiency	η_C		60	71	−	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz, P_o=28W	−	0.95 +j3.0	−	Ω
Series Equivalent Output Impedance	Z_{OUT}		−	2.0 +j1.5	−	Ω

Fig. P_o TEST CIRCUIT



C_1, C_2, C_5, C_6	: 3.5 ~ 30pF
C_3	: 68pF CERAMIC CONDENSER
C_4	: 82pF CERAMIC CONDENSER
C_7	: 1000pF FEED THROUGH
C_8	: 0.02μF CERAMIC CONDENSER
C_9	: 10μF
L_1, L_2	: ϕ1 SILVER PLATED COPPER WIRE, 12ID, 1T
L_3	: ϕ1 SILVER PLATED COPPER WIRE, 12ID, 2T
RFC	: ϕ0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T
FB	: FERRITE BEADS

$P_o, \eta_c - P_i$



2SC2641

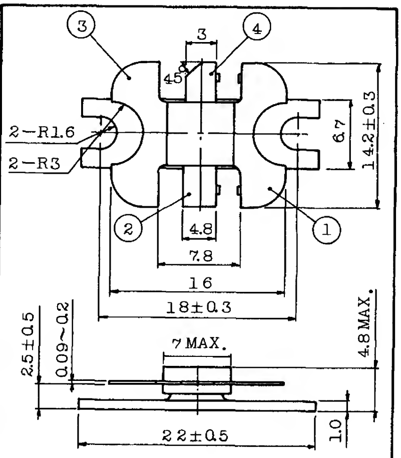
SILICON NPN EPITAXIAL PLANAR TYPE

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=6W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=1W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_O=6.5W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−7A1A

Weight : 1.9g

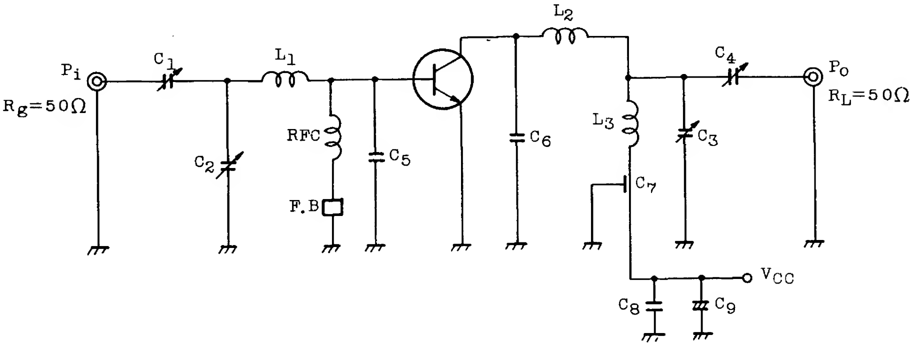
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	Tstg	-65~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	-	-	V
Emitter-Base Breqkdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	10	-	-	
Collector Output Capacitance	Cob	V_{CB}=10V, I_E=0, f=1MHz	-	-	25	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=1W	6	-	-	W
Power Gain	Gpe		7.7	-	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=6W	-	1.6+j4.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	6.5-j5	-	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1,C_2,C_3,C_4 : ~20pF

C_5,C_6 : 10pF

C_7 : 0.01μF

C_8 : 0.02μF

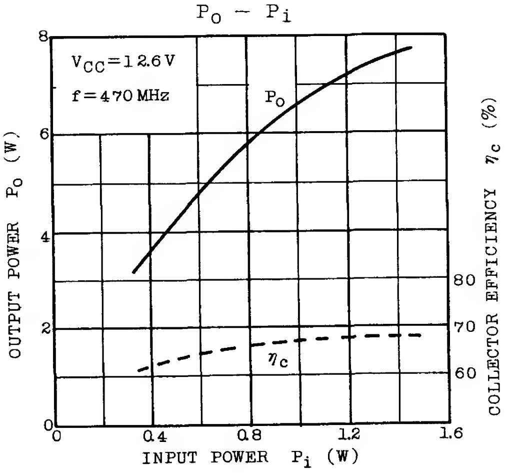
C_9 : 10μF

L1,L2 : 5mm ×10mm COPPER PLATE

L3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERRITE BEADS



2SC2642

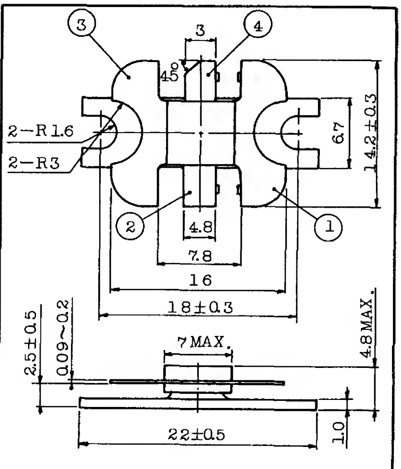
SILICON NPN EPITAXIAL PLANAR TYPE

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=12W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=3W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=3W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	−
EIAJ	−
TOSHIBA	2−7A1A

Weight : 1.6g

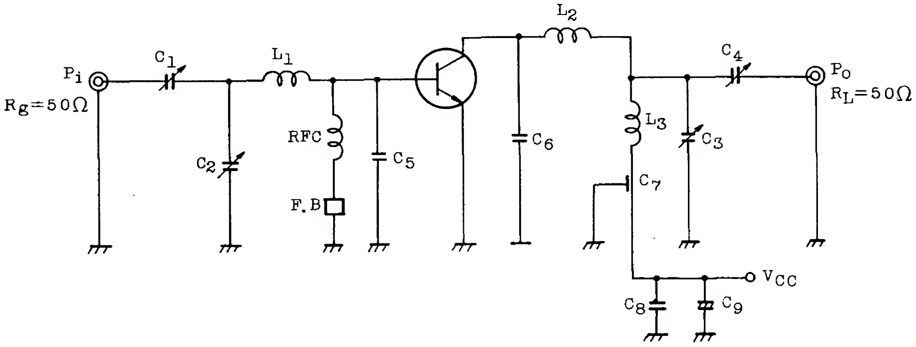
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	Tstg	-65∼175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	−	−	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	−	−	V
Collector-Emitter Breakdwon Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	17	−	−	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.2mA, I_C=0	3.5	−	−	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1.5A	10	−	−	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	−	45	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=3W	12	−	−	W
Power Gain	G_{pe}		6	−	−	dB
Collector Efficiency	η_c		60	−	−	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=12W	−	1.2+j4	−	Ω
Series Equivalent Output Impedance	Z_{OUT}		−	4+j0.5	−	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : ~20pF

C_5, C_6 : 10pF

C_7 : 0.01μF

C_8 : 0.02μF

C_9 : 10μF

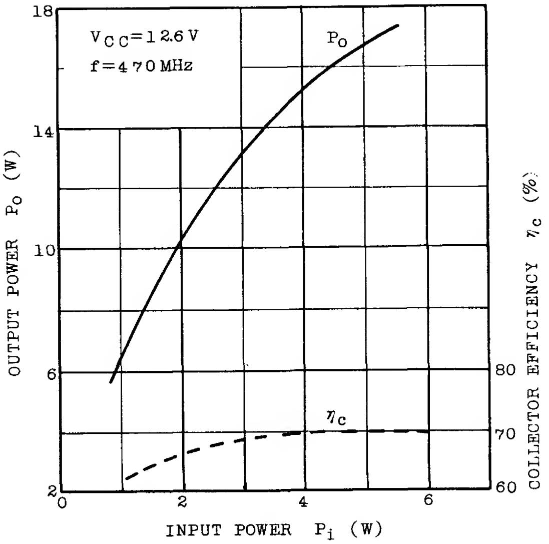
L_1, L_2 : 5mm × 10mm COPPER PLATE

L_3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERRITE BEADS

$P_o - P_i$



2SC2643

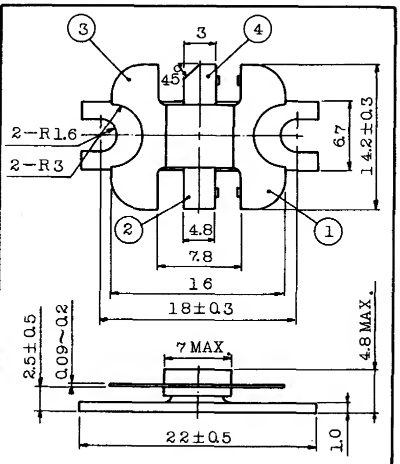
SILICON NPN EPITAXIAL PLANAR TYPE

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=25W(Min.)
  (f=470MHz, V_{CC}=12.6V, P_i=8W)
- 100% Tested for Load Mismatch Stress at all Phase Angles with 30:1 VSWR @ V_{CC}=12.6V, P_i=8W, f=470MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−7A1A

Weight : 1.6g

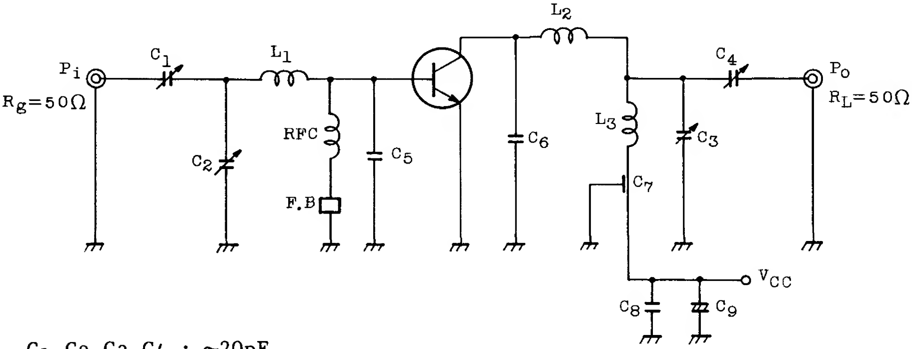
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=25mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=3A	10	-	-	
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	80	pF
Output Power	P_o	(Fig.) V_{CC}=12.6V, f=470MHz, P_i=8W	25	27	-	W
Power Gain	G_{pe}		4.9	5.3	-	dB
Collector Efficiency	η_c		60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.6V, f=470MHz, P_o=25W	-	4+j3	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3+j1	-	Ω

Fig. f=470MHz P_O TEST CIRCUIT



C_1,C_2,C_3,C_4 : ~20pF

C_5,C_6 : 10pF

C_7 : 0.01μF

C_8 : 0.02μF

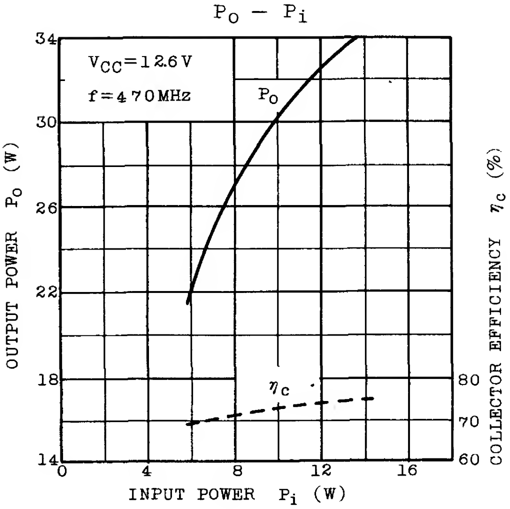
C_9 : 10μF

L_1,L_2 : 5mm ×10mm COPPER PLATE

L_3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERITE BEADS



2SC2650

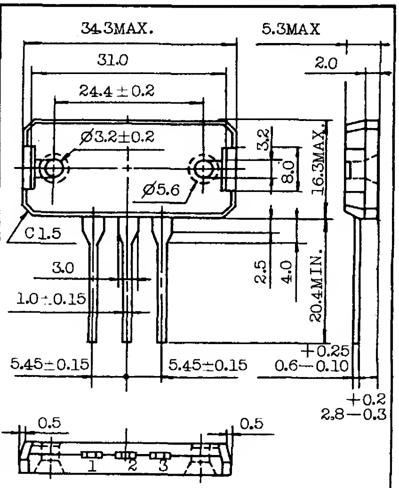
SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Tims
  : t_r=1.0μs Max. , t_f=1.0μs Max. (IC=5A)
- High Collector Breakdown Voltage : V_{CEO}=400V



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

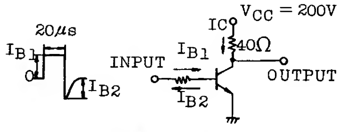
JEDEC	—
EIAJ	—
TOSHIBA	2 — 34A1A

Weight : 10.8g

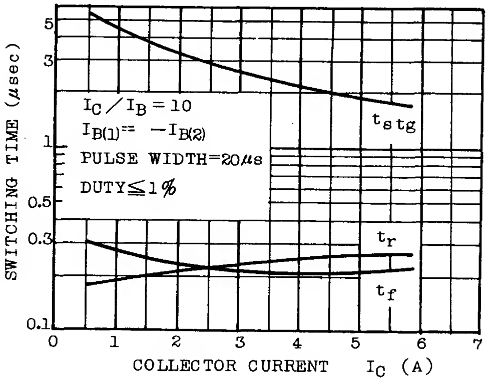
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

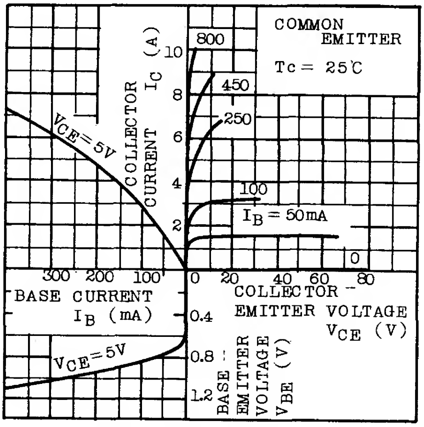
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	7	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=5A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Switching Time	Rise Time	t_r	 20μs I_{B1} 0 I_{B2} INPUT I_{B1} I_{B2} IC V_{CC} = 200V 40Ω OUTPUT DUTY CYCLE≦1%, I_{B1}=−I_{B2}=0.5A	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

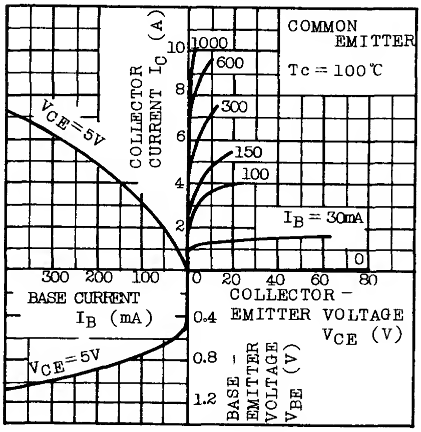
SWITCHING CHARACTERISTICS



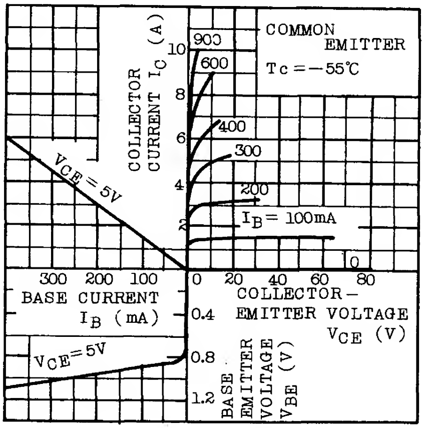
STATIC CHARACTERISTICS



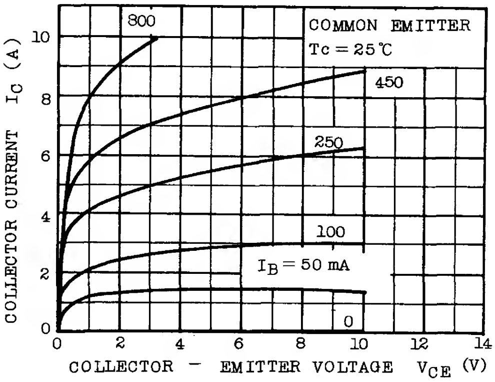
STATIC CHARACTERISTICS



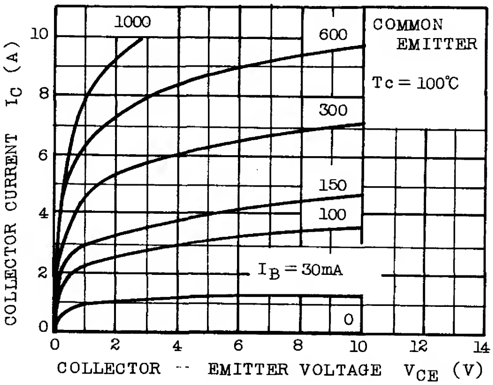
STATIC CHARACTERISTICS



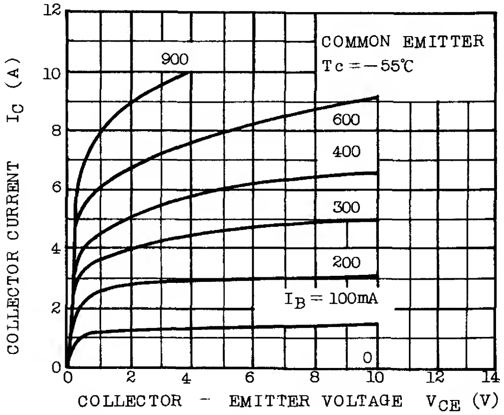
I_C – V_{CE} (LOW VOLTAGE REGION)



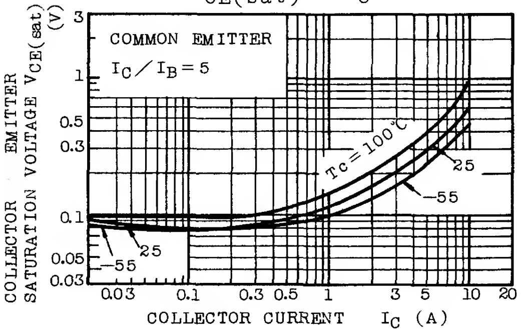
I_C – V_{CE} (LOW VOLTAGE REGION)



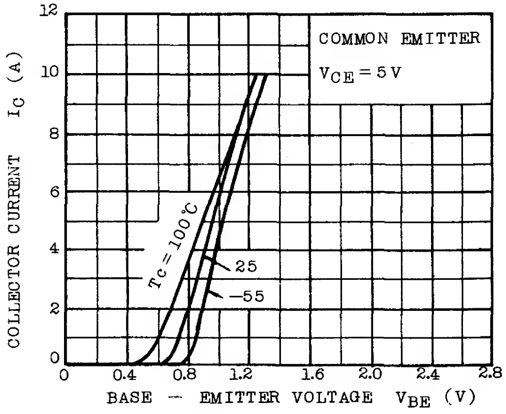
I_C – V_{CE} (LOW VOLTAGE REGION)



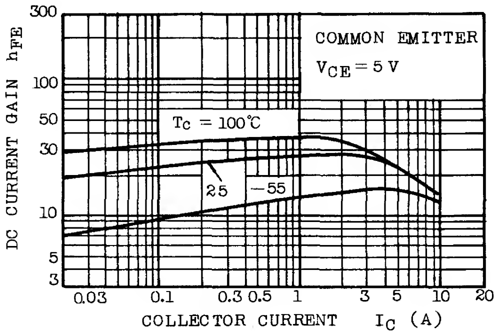
$V_{CE(sat)}$ – I_C



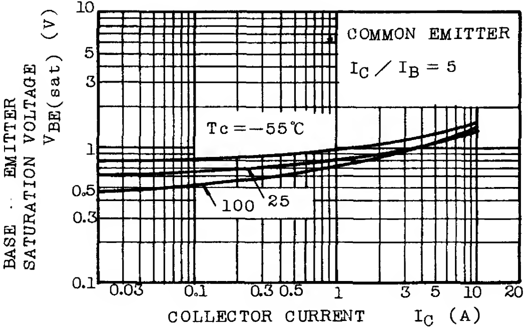
I_C – V_{BE}



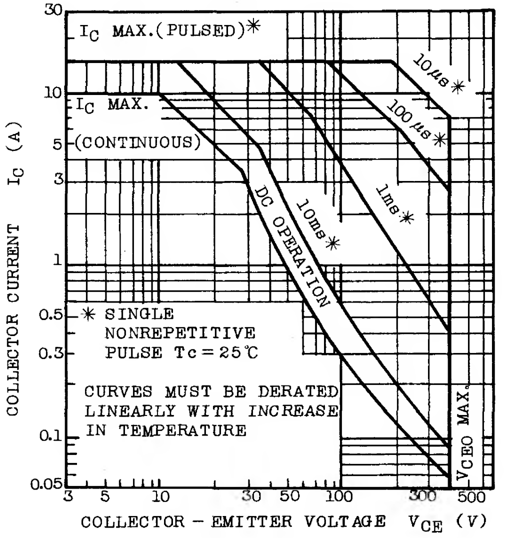
h_{FE} – I_C



$V_{BE(sat)}$ – I_C



SAFE OPERATING AREA



SILICON NPN EPITAXIAL PLANAR TYPE

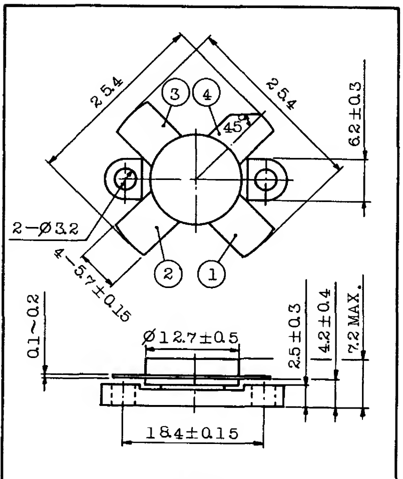
2SC2652

2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(50V SUPPLY VOLTAGE USE)

FEATURES

- Specified 50V, 28MHz Characteristics
  - : Output Power : P_O=200W_{PEP}
  - : Minimum Gain : G_{pe}=13dB
  - : Efficiency : η_c=35% (Min.)
  - : Intermodulation Distortion : IMD=-30dB(Max.)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR
  @ V_{CC}=50V, P_O=150W_{PEP}, f=28MHz

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2-13B1A

Weight : 5.2g

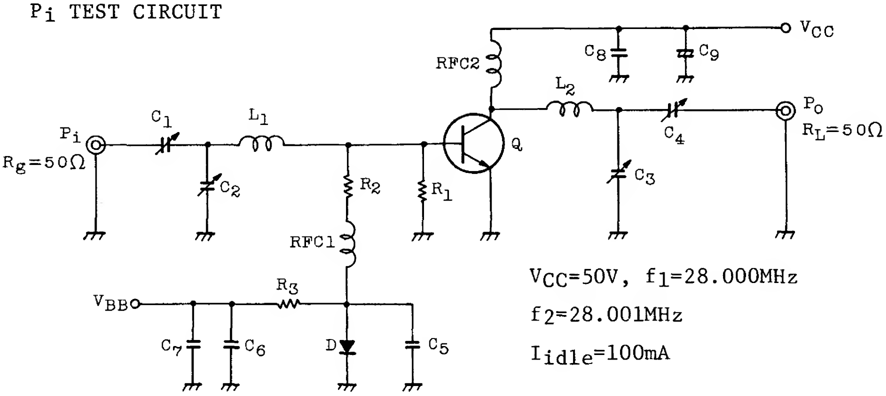
MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	85	V
Collector-Emitter Voltage	V_{CES}	85	V
Collector-Emitter Voltage	V_{CEO}	55	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation (T_c=25 °C)	P_C	300	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

ELECTRICAL CHARACTERISTICS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	55	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=100mA, V_{BE}=0	85	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=10A	10	-	150	
Collector Output Capacitance	C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	300	-	pF
Power Gain	G_{pe}	V_{CC}=50V, f=28MHz	13.0	15.2	-	dB
Input Power	P_i	2-Tone, Δf=1kHz	-	6	10	W_{PEP}
Collector Efficiency	η_c	I_{idle}=100mA, P_O=200W_{PEP}	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=50V, f=28MHz	-	1.15 -j1.15	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	Δf=1kHz, P_O=200W_{PEP}	—	5.4 -j2.0	-	Ω

Fig. P_i TEST CIRCUIT



V_{CC}=50V, f_1=28.000MHz

f_2=28.001MHz

I_{idle}=100mA

C_1,C_2 : 7~150pF

C_3,C_4 : 7~150pF 2KWV

C_5,C_6 : 0.022μF

C_7 : 47μF 10WV

C_8 : 0.044μF

C_9 : 100μF 50WV

Q : 2SC2652

L_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P

L_2 : ϕ1.2 ENAMEL COATED COPPER WIRE, 14ID, 3½T, 3P

RFC1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 10ID, 9T (ferrite Core TDK K2)

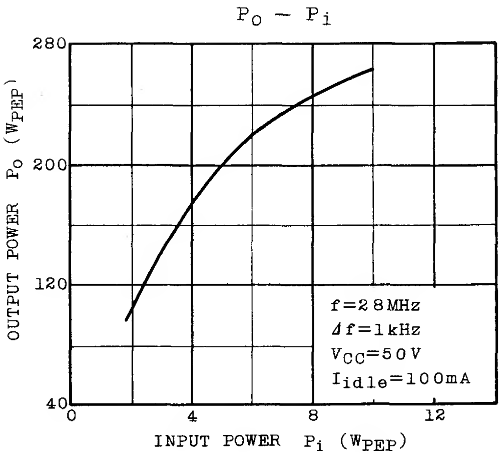
RFC2 : ϕ0.8 ENAMEL COATED COPPER WIRE, 14ID, 20T

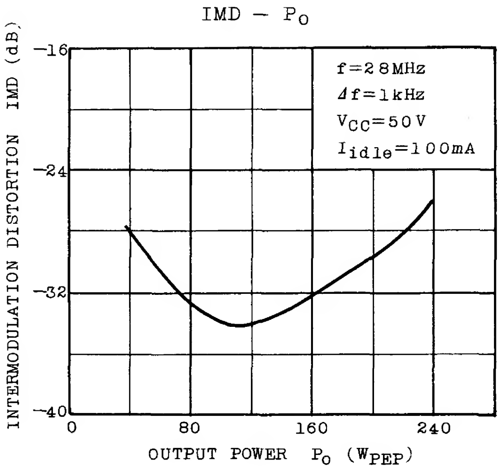
R_1 : 10Ω (1W)

R_2 : 2Ω (1/2W)

R_3 : 10Ω (5W)

D : 1S1555





SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

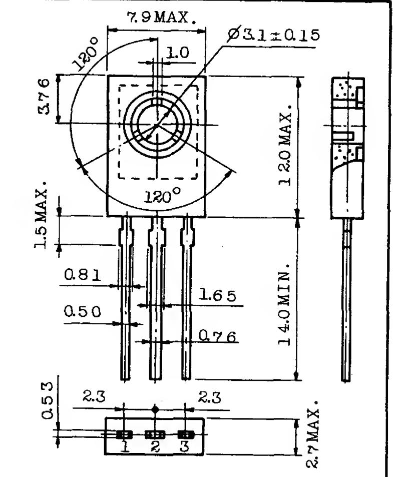
2SC2704

AUDIO FREQUENCY AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1144.
- Small Collector Output Capacitance : C_{ob}=1.8pF(Typ.)
- High Transition Frequency : f_T=200MHz(Typ.)

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Mounting Kit No. AC46C
Weight : 0.72g

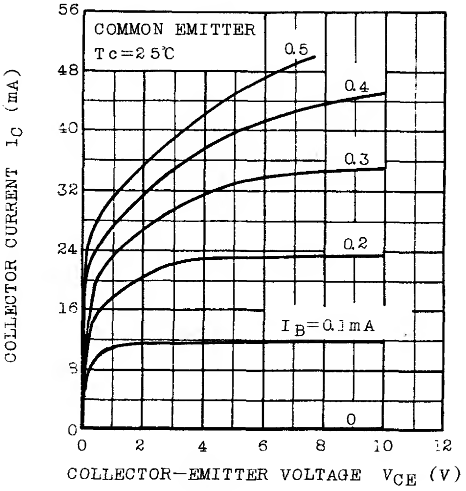
MAXIMUM RATINGS (T_a=25°C)

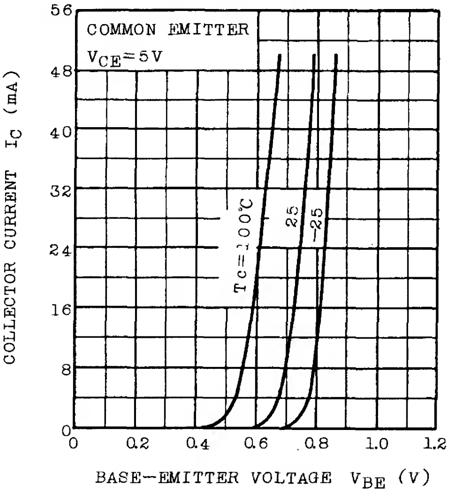
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	150	V
Collector-Emitter Voltage	V_{CEO}	150	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	50	mA
Base Current	I_B	5	mA
Collector Power Dissipation (T_c=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

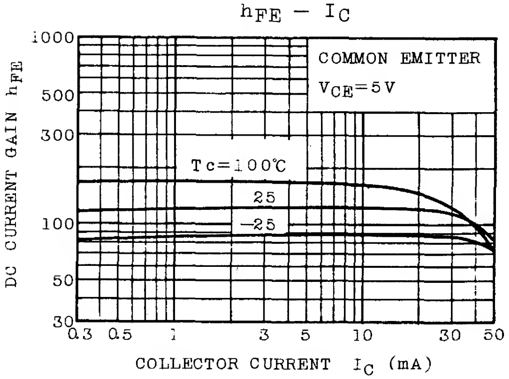
ELECTRICAL CHARACTERISTICS (T_a=25°C)

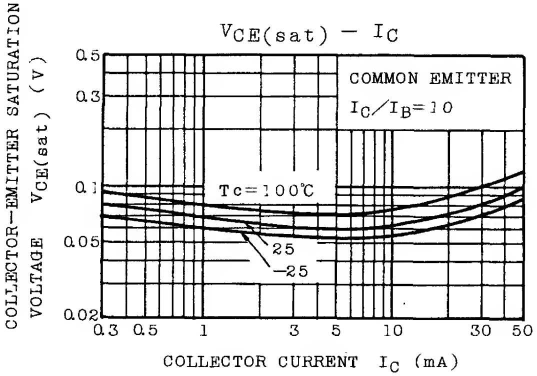
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=150V, I_E=0	−	−	0.1	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	−	−	0.1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=1mA, I_B=0	150	−	−	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=10mA	80	−	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10mA, I_B=1mA	−	−	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=10mA	−	−	0.8	V
Transition Frequency	f_T	V_{CE}=10V, I_C=10mA	−	200	−	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	1.8	−	pF

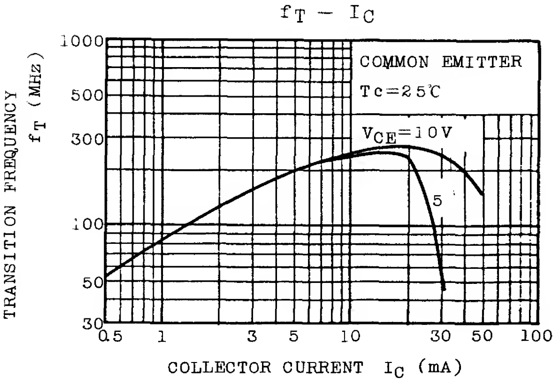
Note: h_{FE} Classification. O:80~160, Y:120~240

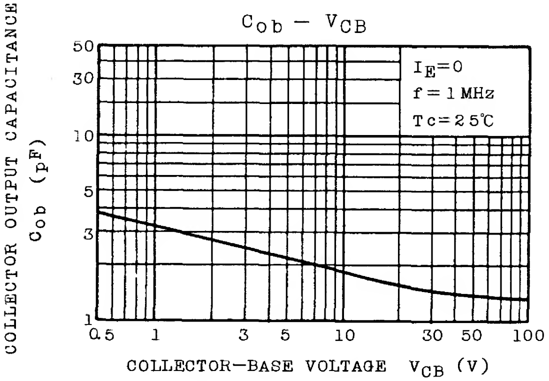

$I_C - V_{CE}$

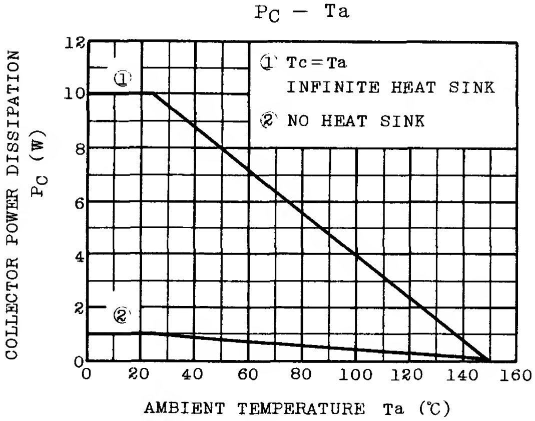

$I_C - V_{BE}$


$h_{FE} - I_C$


$V_{CE(sat)} - I_C$


$f_T - I_C$


$C_{ob} - V_{CB}$


P_C – Ta
① Tc = Ta
INFINITE HEAT SINK
② NO HEAT SINK
①
②
COLLECTOR POWER DISSIPATION P_C (W)
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE Ta (℃)

2SC2706

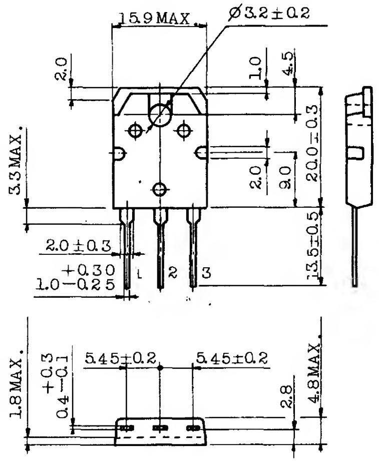
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1146.
- Recommended for 70W audio frequency amplifier output stage.
- High transition frequency : f_T=90MHz(Typ.)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

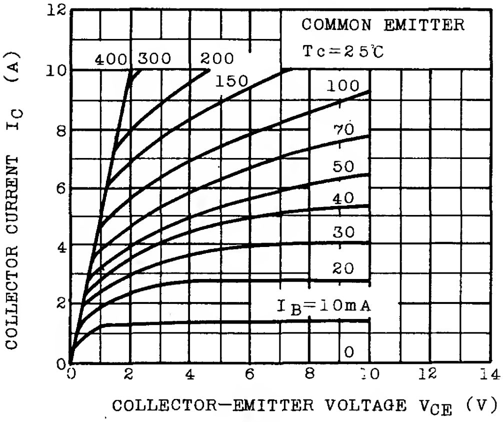
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	140	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

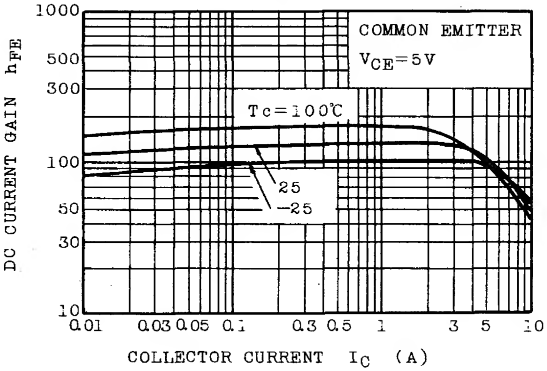
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=140V, I_E=0	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=5A	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	-	2.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	90	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	130	-	pF

Note: h_{FE} Classification. R:55~110, O:80~160, Y:120~240

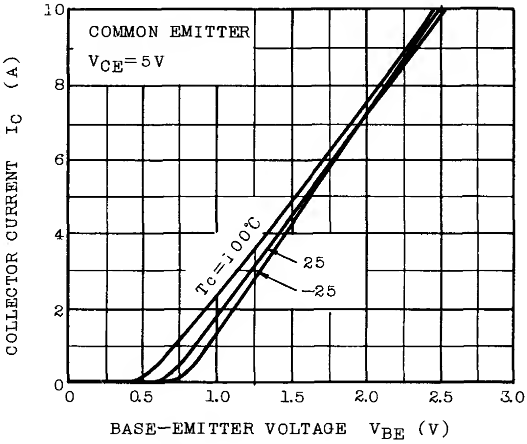
I_C — V_{CE}



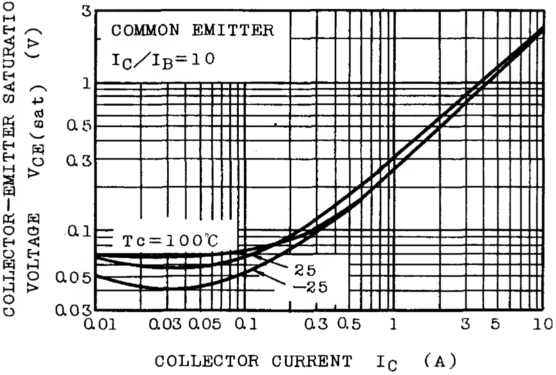
h_{FE} — I_C



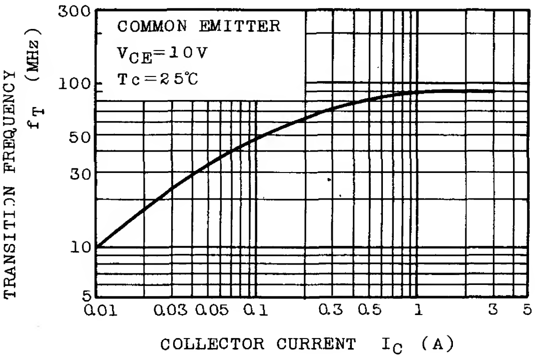
I_C — V_{BE}



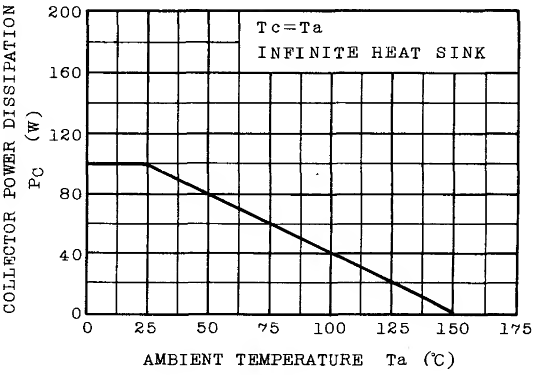
$V_{CE(sat)}$ — I_C

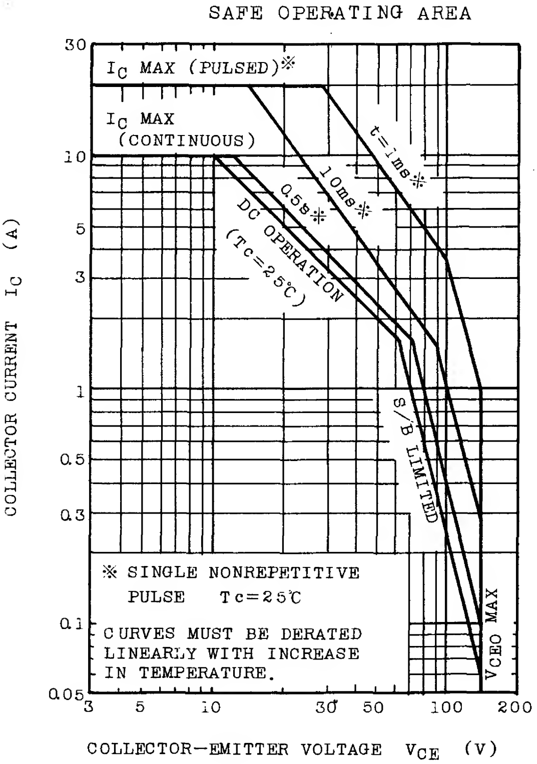


f_T — I_C



P_C — Ta




SAFE OPERATING AREA
I_C MAX (PULSED)※
I_C MAX (CONTINUOUS)
t=1ms※
10ms※
0.5s※
DC OPERATION (Tc=25℃)
S/B LIMITED
V_CEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
COLLECTOR CURRENT I_C (A)
COLLECTOR-EMITTER VOLTAGE V_CE (V)
30
10
5
3
1
0.5
0.3
0.1
0.05
3
5
10
30
50
100
200

SILICON NPN EPITAXIAL PLANAR TYPE

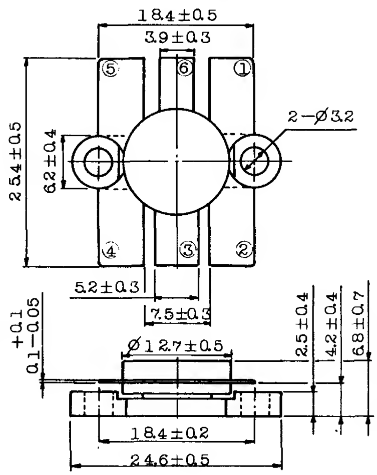
2SC2782

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : Po=80W (Min.)
  (f=175MHz, V_{CC}=12.5V, P_i=18W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.5V, P_O=80W, f=175MHz

Unit in mm



1. EMITTER
2. EMITTER
3. BASE
4. EMITTER
5. EMITTER
6. COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2−13C1A

Weight : 5.5g

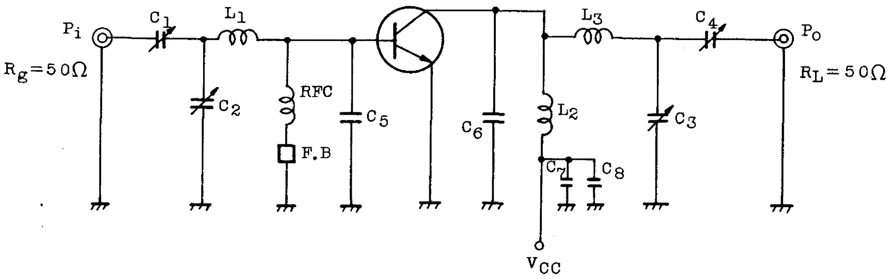
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	16	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation (Tc=25 °C)	P_C	220	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	Tstg	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=20mA, I_E=0	36	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	16	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E= 1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=10A	10	-	-	
Collector Output Capacitance	Cob	V_{CB}=12.5V, I_E=0, f=1MHz	-	-	320	pF
Output Power	Po	(Fig.)	80	90	-	W
Power Gain	Gpe	V_{CC}=12.5V, f=175MHz	6.4	6.8	-	dB
Collector Efficiency	η_c	P_i=18W	60	70	-	%
Series Equivalent Input Impedance	Z_{in}	V_{CC}=12.5V, f=175MHz	-	1.0 +j1.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	P_O=80W	—	1.2 +j18	-	Ω

Fig. P_o TEST CIRCUIT



$C_1 \sim C_4$: ~20pF

C_5 : 156pF (39pF × 4) CERAMIC CONDENSER

C_6 : 132pF (33pF × 4) CERAMIC CONDENSER

C_7 : 0.01μF CERAMIC CONDENSER

C_8 : 10μF

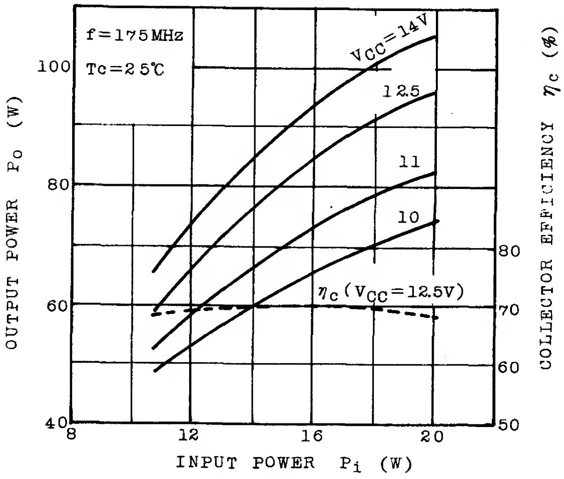
L_1, L_3 : ϕ1.5mm SILVER PLATED COPPER WIRE, 10 ID, 1T

L_2 : ϕ1.5mm SILVER PLATED COPPER WIRE, 10 ID, 2T

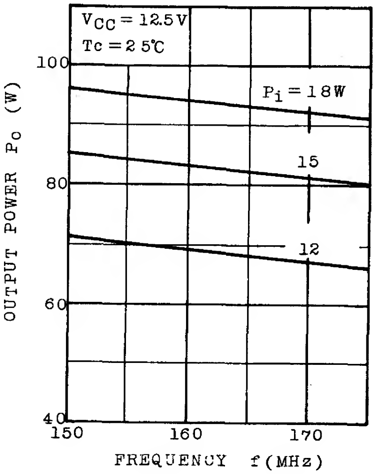
RFC : ϕ1mm ENAMEL COATED COPPER WIRE, 6 ID, 10T

FB : FERRITE BEAD

$P_o, \eta_c - P_i$



$P_o - f$



SILICON NPN EPITAXIAL PLANAR TYPE

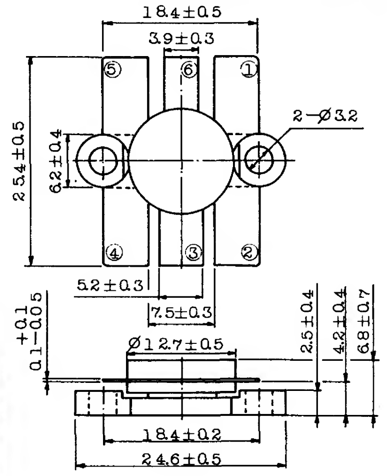
2SC2783

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : P_O=40W(Min.)
  (f=470MHz, V_{CC}=12.5V, P_i=13W)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ V_{CC}=12.5V, P_i=13W, f=470MHz

Unit in mm



1. EMITTER
2. EMITTER
3. BASE
4. EMITTER
5. EMITTER
6. COLLECTOR

JEDEC	−
EIAJ	−
TOSHIBA	2−13C1A

Weight : 5.5g

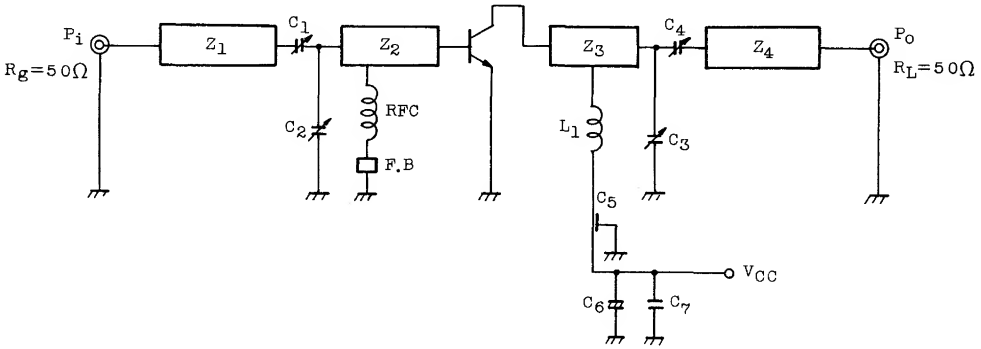
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	16	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	8	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	−65 ∼175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	−	−	6	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	36	−	−	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	16	−	−	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	−	−	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=5A	10	−	150	
Collector Output Capacitance	C_{ob}	V_{CB}=12.5V, I_E=0, f=1MHz	−	110	150	pF
Output Power	P_o	(Fig.)	40	45	−	W
Power Gain	G_{pe}	V_{CC}=12.5V, f=470MHz, P_i=13W	4.88	5.4	−	dB
Collector Efficiency	η_c		60	65	−	%
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.5V, f=470MHz, P_o=40W	−	3+j3.2	−	Ω
Series Equivalent Output Impedance	Z_{OUT}		−	1.7+ j4.7	−	Ω

Fig. f=470MHz P_o TEST CIRCUIT



C_1 ~ C_4 : ~ 20pF

C_5 : 1000pF

C_6 : 10μF

C_7 : 0.1μF

F.B : FERRITE BEADS

L_1 : ϕ1 SILVER PLATED COPPER WIRE, 6ID, 3T

RFC : ϕ1 ENAMEL COATED COPPER WIRE, 6ID, 10T

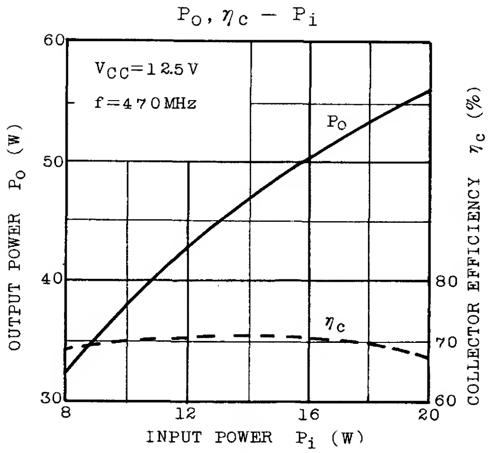
Z_1 : 4mm × 40mm MICROSTRIP

Z_2 : 6mm × 23mm MICROSTRIP

Z_3 : 6mm × 23mm MICROSTRIP

Z_4 : 4mm × 30mm MICROSTRIP

BOARD : 1.6mm TEFLONGLASS ϵ_R=2.5



SILICON NPN TRIPLE DIFFUSED TYPE

2SC2790

INDUSTRIAL APPLICATIONS

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

. Excellent Switching Times

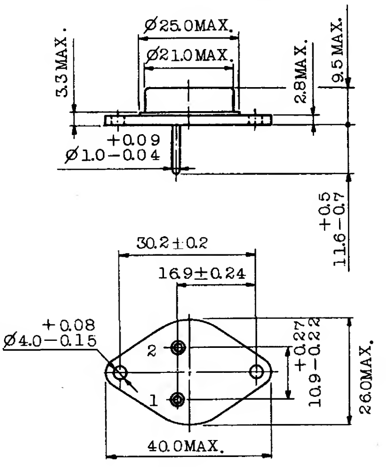
: t_r=1.0μs Max. , t_f=1.0μs Max. at I_C=0.5A

. High Collector Breakdown Voltage : V_{CEO}=800V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector - Base Voltage	V_{CBO}	850	V
Collector - Emitter Voltage	V_{CEO}	800	V
Emitter - Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

Unit in mm

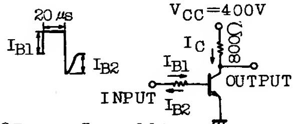


1. BASE
2. EMITTER
COLLECTOR(HEAT SINK)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21E1A

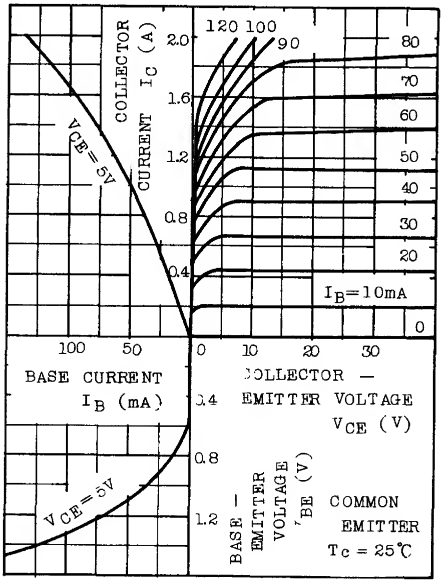
Weight : 16g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

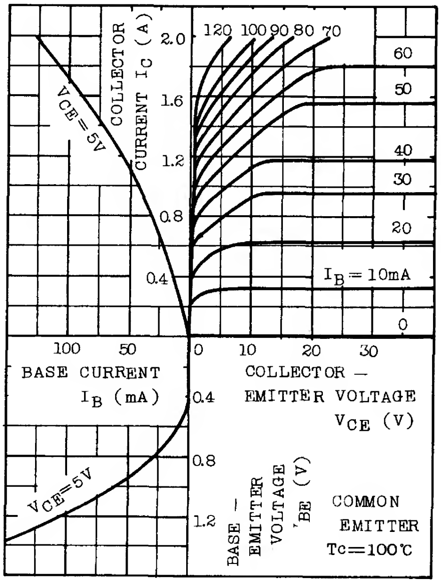
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	850	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
DC Current Gain		h_{FE}(Note)	V_{CE}=5V, I_C=0.5A	17	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$ (Note)	I_C=0.5A, I_B=0.05A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$ (Note)	I_C=0.5A, I_B=0.05A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} V_{CC}=400V I_C 800Ω I_{B1} OUTPUT INPUT I_{B2} $2I_{B1}=-I_{B2}=0.1A$ DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

Note : Pulse Test : Pulse Width≦300μs, Duty Cycle≦2%

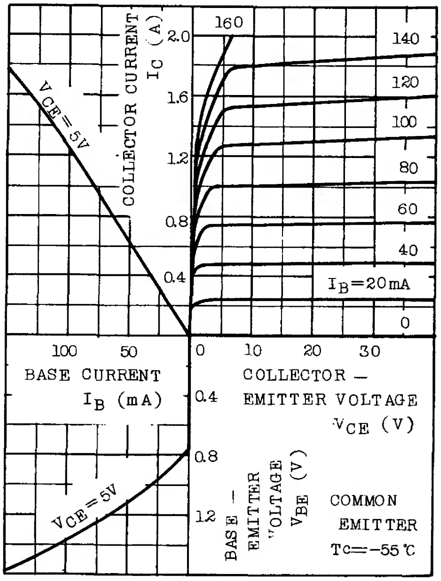
STATIC CHARACTERISTICS



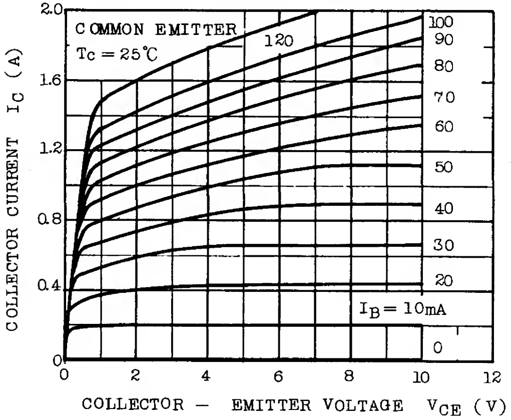
STATIC CHARACTERISTICS



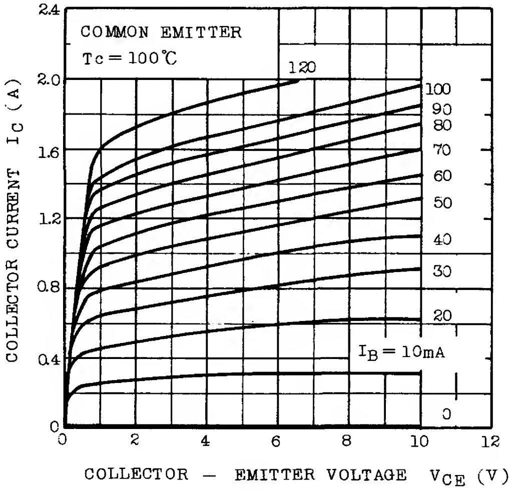
STATIC CHARACTERISTICS



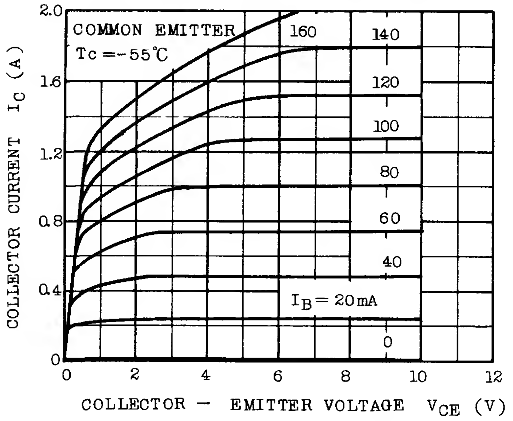
I_C – V_{CE} (LOW VOLTAGE REGION)



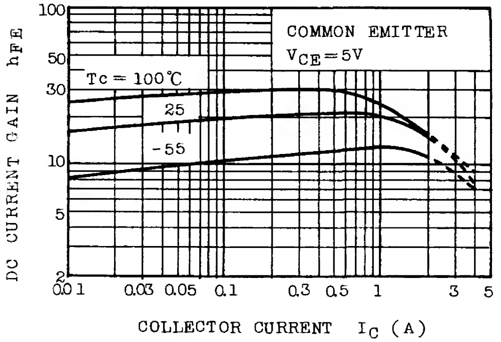
I_C – V_{CE} (LOW VOLTAGE REGION)



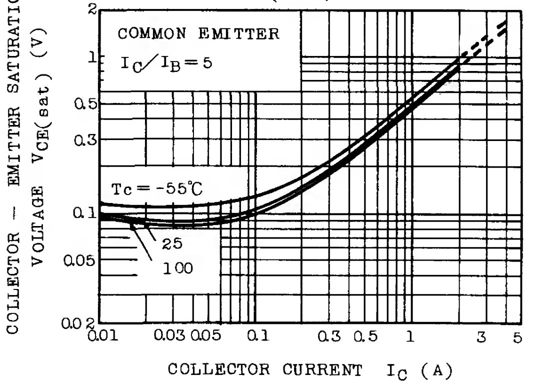
I_C – V_{CE} (LOW VOLTAGE REGION)



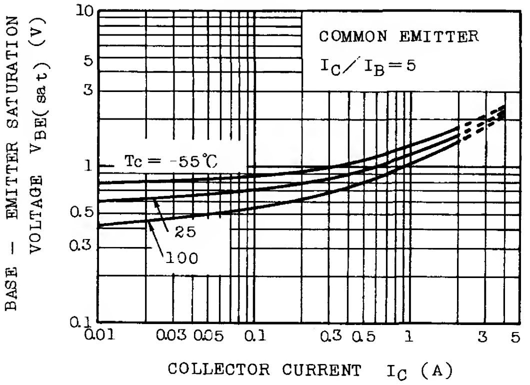
h_{FE} – I_C



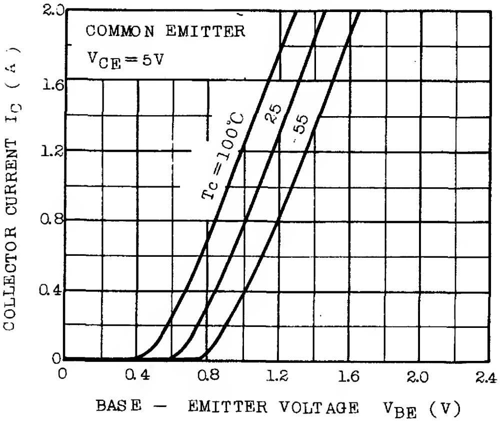
$V_{CE(sat)}$ – I_C



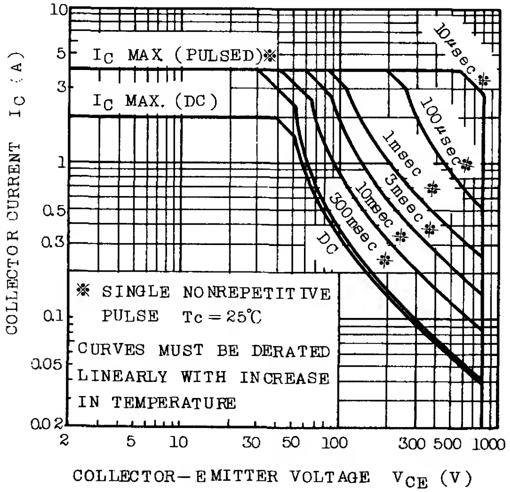
$V_{BE(sat)}$ – I_C



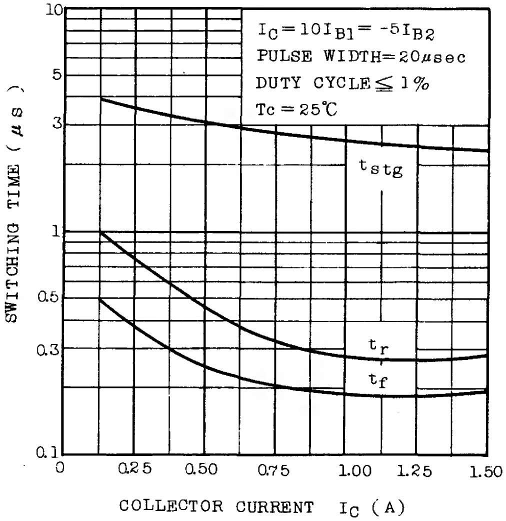
I_C – V_{BE}



SAFE OPERATING AREA



SWITCHING CHARACTERISTICS



SILICON NPN TRIPLE DIFFUSED TYPE

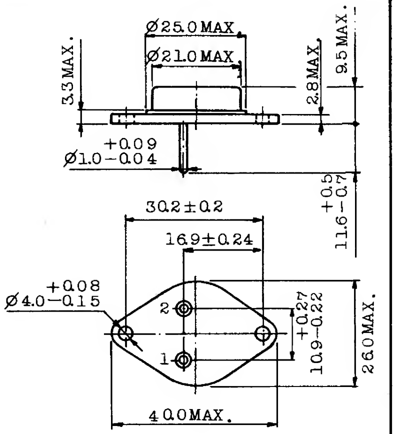
2SC2791

HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Times
  : t_r=1.0μs (Max.), t_f=1.0μs (Max.)(I_C=3A)
- High Collector Breakdown Voltage : V_{CEO}=800V

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

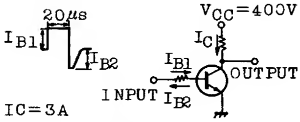
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

MOUNTING KIT No. AC100
Weight : 16g

MAXIMUM RATINGS (T_a=25°C)

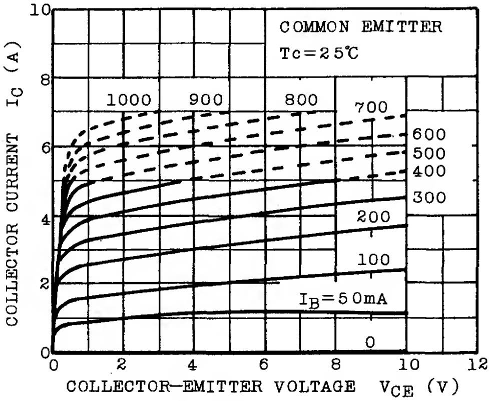
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	900	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	5	A
Base Current	I_B	3	A
Collector Power Dissipation (T_c=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

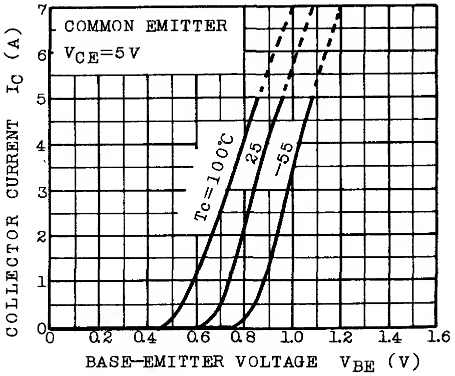
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	−	−	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	−	−	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	−	−	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=10mA (Note)	10	−	−	
		$h_{FE(2)}$	V_{CE}=5V, I_C=3A (Note)	10	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.6A (Note)	−	−	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=0.6A (Note)	−	−	1.5	V
Switching Time	Rise Time	t_r	 IC=3A I_{B1}=0.3A, I_{B2}=−0.8A DUTY CYCLL≦1%	−	−	1.0	μs
	Storage Time	t_{stg}		−	−	3.5	
	Fall Time	t_f		−	−	1.0	

Note : Pulse Test : Pulse Width≦300μs, Duty Cycle≦2%

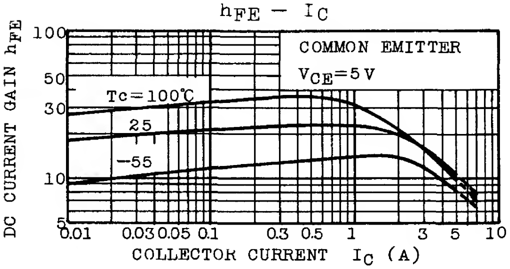
$I_C - V_{CE}$



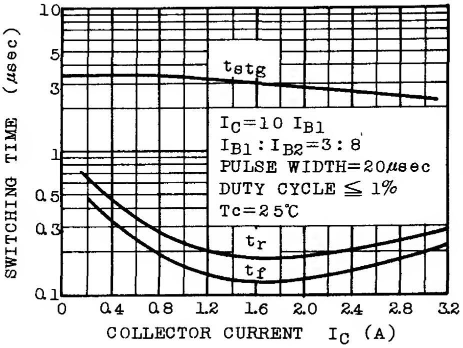
$V_{BE} - I_C$



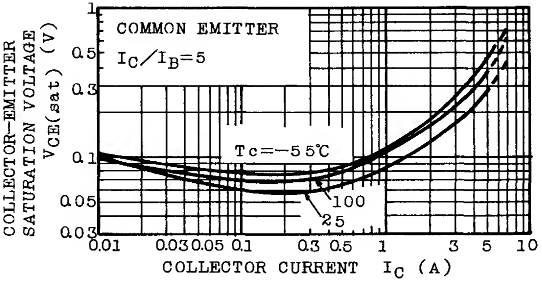
$h_{FE} - I_C$



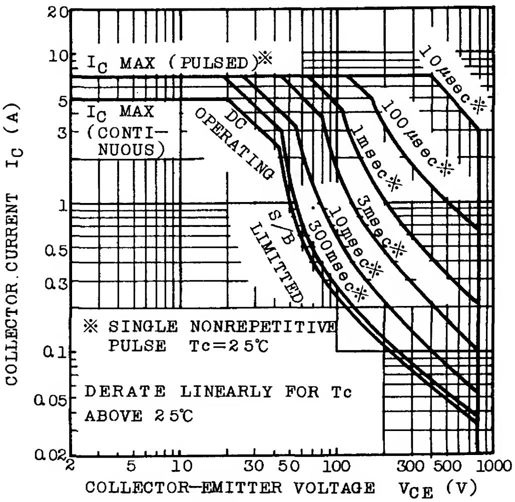
SWITCHING CHARACTERISTICS



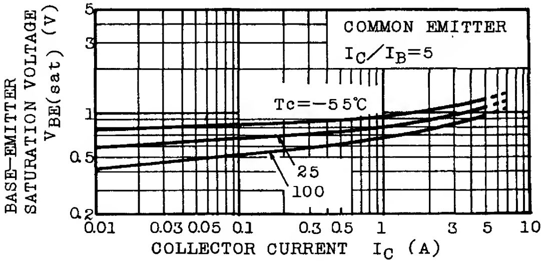
$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



$V_{BE(sat)} - I_C$



SILICON NPN TRIPLE DIFFUSED TYPE

2SC2792

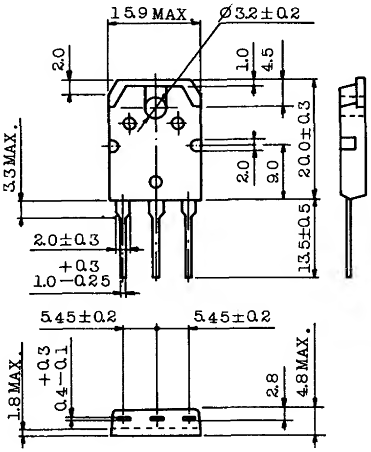
INDUSTRIAL APPLICATIONS

SWITCHING REGULATOR AND HIGH VOLTAGE.
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times (I_C=0.5A)
  t_r=1.0μs Max. t_f=10.μs Max.
- High Collector Breakdown Voltage : V_{CEO}=800V

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

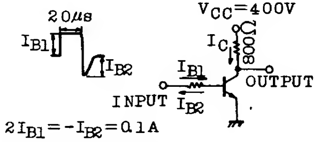
JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

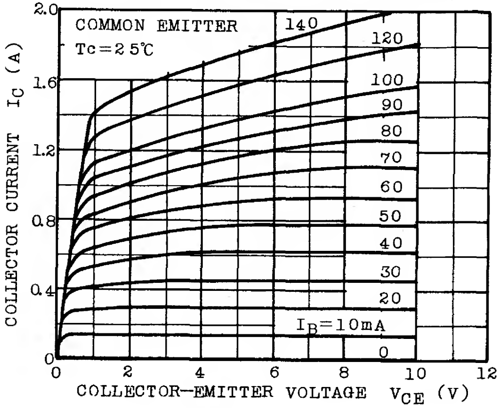
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	850	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	1	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	-55～150	°C

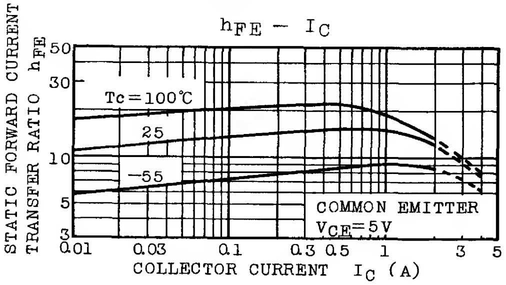
ELECTRICAL CHARACTERISTICS (T_a=25°)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cutoff Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	850	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
D C Current Gain (Note)		h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector-Emitter Saturation Voltage (Note)		$V_{CE(sat)}$	I_C=0.5A, I_B=0.05A	-	-	1.0	V
Base-Emitter Saturation Voltage (Note)		$V_{BE(sat)}$	I_C=0.5A, I_B=0.05A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs V_{CC}=400V I_{B1} I_{B2} I_C 800Ω I_{B1} OUTPUT INPUT I_{B2} $2I_{B1}=-I_{B2}$=0.1A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

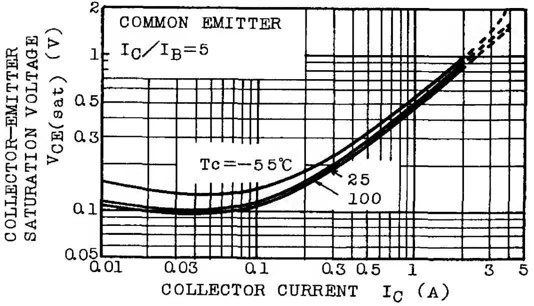
Note ; Pulse Test : Pulse Width≦300μs, Duty Cycle≦2%



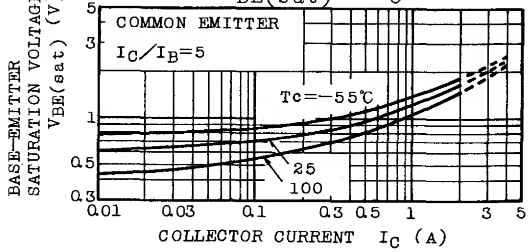
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



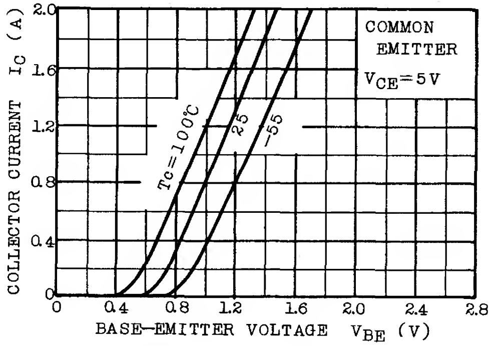
$h_{FE} - I_C$



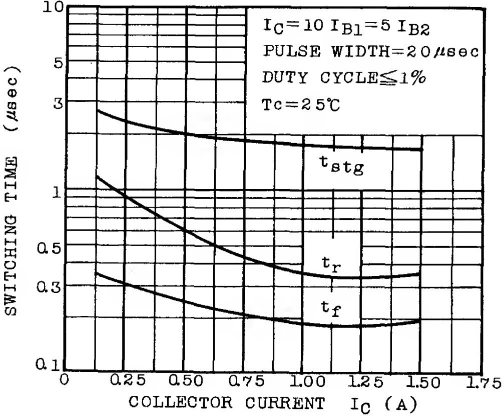
$V_{CE(sat)} - I_C$



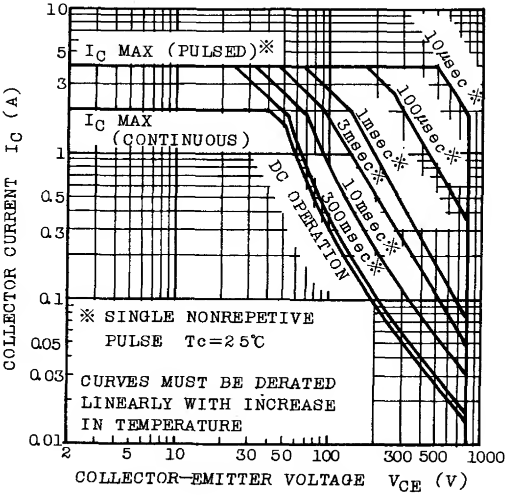
$V_{BE(sat)} - I_C$



$V_{BE} - I_C$



SWITCHING TIME – I_C



SAFE OPERATING AREA

SILICON NPN TRIPLE DIFFUSED TYPE

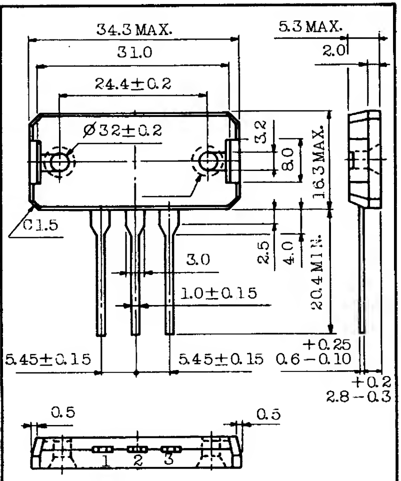
2SC2793

HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Times
  : t_r=1.0μs (Max.), t_f=1.0μs (Max.) (I_C=3A)
- High Collector Breakdown Voltage : V_{CEO}=800V

INDUSTRIAL APPLICATION
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

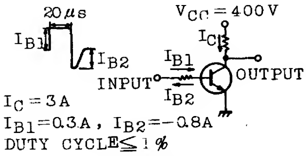
JEDEC	—
EIAJ	—
TOSHIBA	2−34A1A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

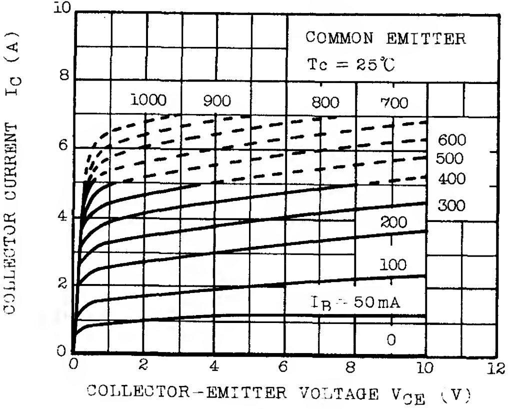
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7	A
Base Current		I_B	3	A
Collector Power Dissipation (Tc=25°C)		P_C	100	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

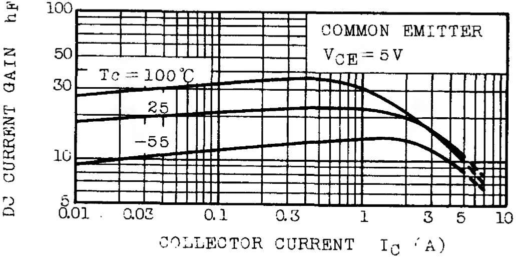
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=10mA (Note)	10	-	-	-
		$h_{FE(2)}$	V_{CE}=5V, I_C=3A (Note)	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.6A (Note)	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=0.6A (Note)	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs V_{CC}=400V I_{B1} I_{B2} I_C I_{B1} I_{B2} INPUT OUTPUT I_C=3A I_{B1}=0.3A, I_{B2}=−0.8A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	3.5	
	Fall Time	t_f		-	-	1.0	

Note: Pulse Test : Pulse Width≦300μs, Duty Cycle≦2%

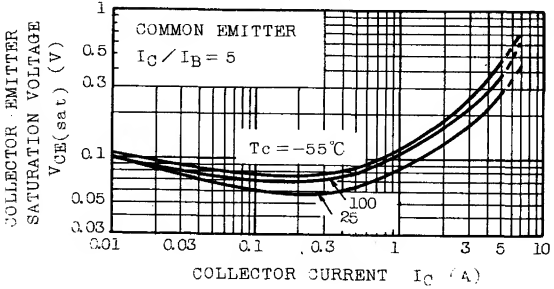
$I_C - V_{CE}$



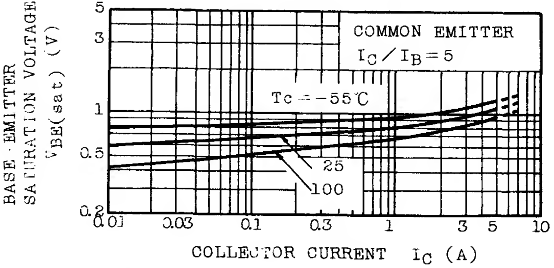
$h_{FE} - I_C$



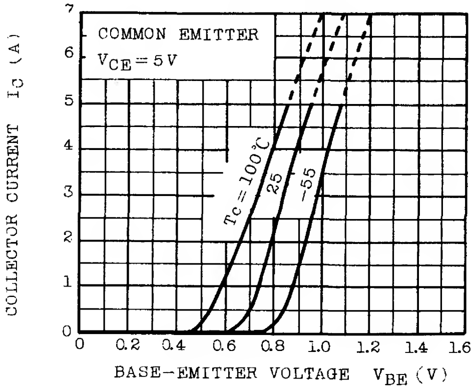
$V_{CE(sat)} - I_C$



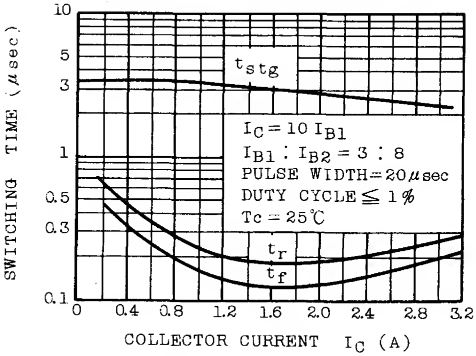
$V_{BE(sat)} - I_C$



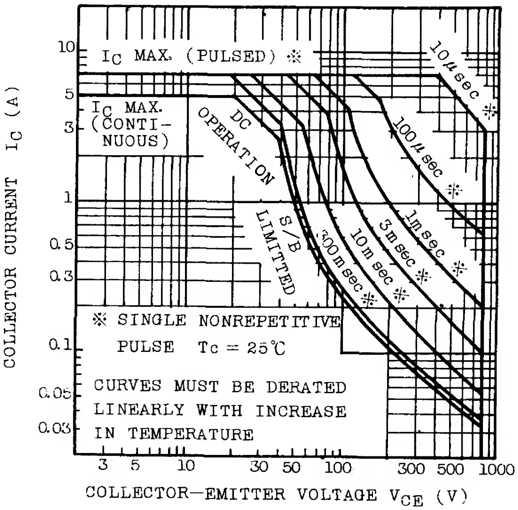
$I_C - V_{BE}$



SWITCHING CHARACTERISTICS



SAFE OPERATING AREA



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

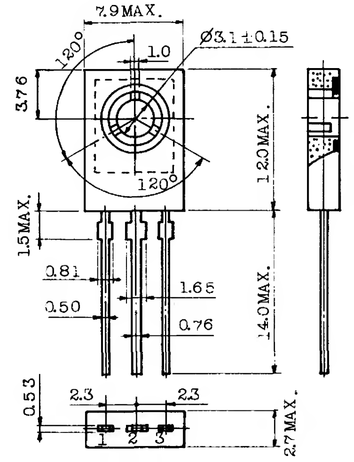
2SC2824

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1184.
- Suitable for driver of 60 to 80 watts audio amplifier.
- High breakdown voltage.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	-
TOSHIBA	2-8F1A

Mounting Kit No. AC46C
Weight : 0.72g

MAXIMUM RATINGS (T_a=25°C)

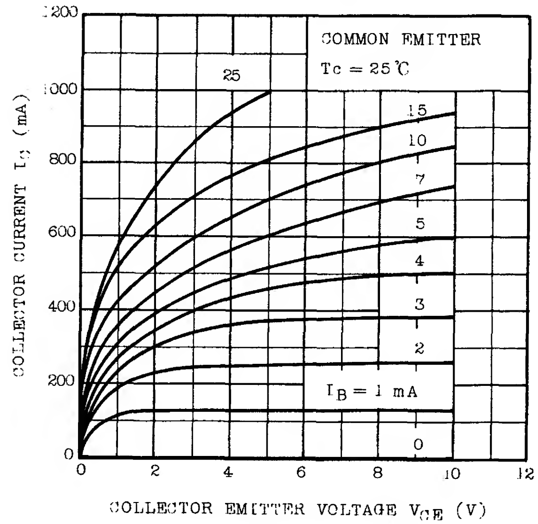
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	120	V
Collector-Emitter Voltage		V_{CEO}	120	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1	A
Base Current		I_B	100	mA
Collector Power Dissipation	T_a=25°C	P_C	1	W
	T_c=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

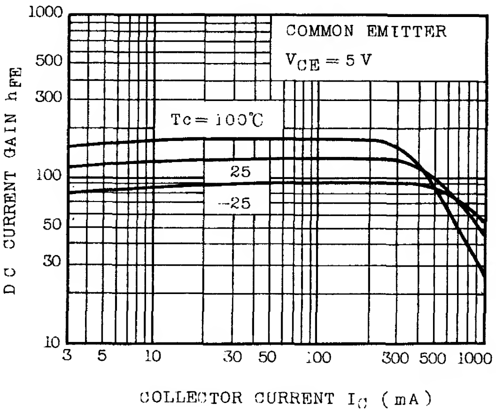
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=120V, I_E=0	-	-	100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	120	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=100mA	80	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	0.30	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=500mA	-	0.78	1.0	V
Transition Frequency	f_T	V_{CE}=5V, I_C=100mA	-	120	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	15	-	pF

Note: h_{FE} Classification O:80~160 Y:120~240

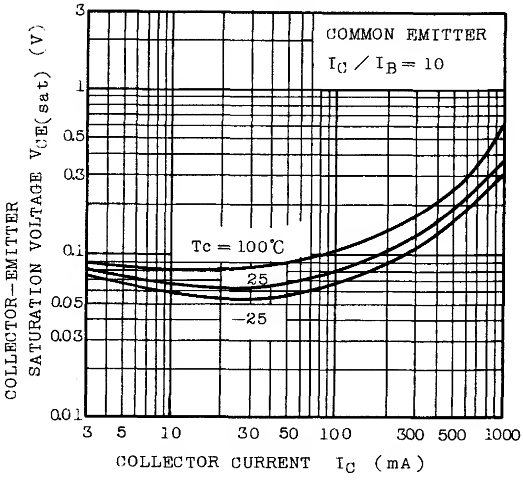
$I_C - V_{CE}$



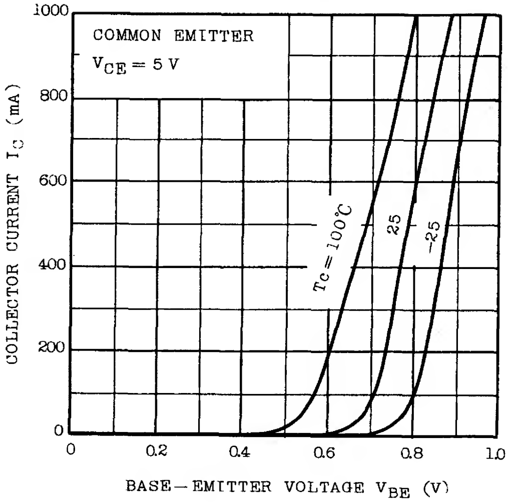
$h_{FE} - I_C$

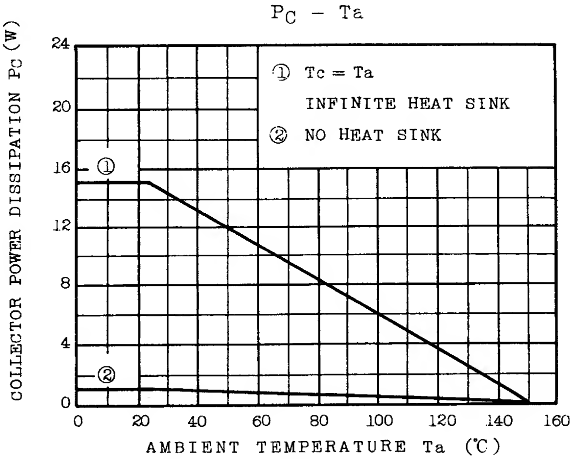


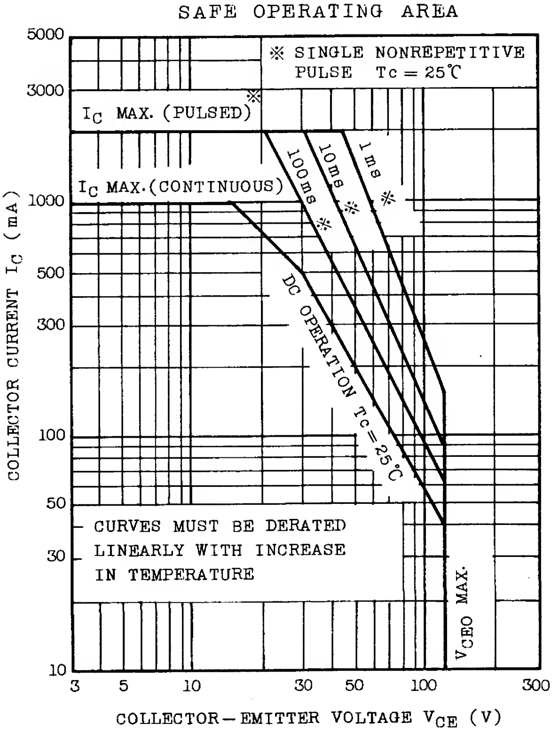
$V_{CE(sat)} - I_C$



$I_C - V_{BE}$




PC – Ta
COLLECTOR POWER DISSIPATION PC (W)
24
20
16
12
8
4
0
① Tc = Ta
INFINITE HEAT SINK
② NO HEAT SINK
①
②
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
IC MAX. (PULSED)※
IC MAX. (CONTINUOUS)
100ms ※
10ms ※
1ms ※
DC OPERATION Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX.
COLLECTOR CURRENT IC (mA)
5000
3000
1000
500
300
100
50
30
10
3
5
10
30
50
100
300
COLLECTOR–EMITTER VOLTAGE VCE (V)

2SC2877

SILICON NPN EPITAXIAL PLANAR TYPE (PCT PROCESS)

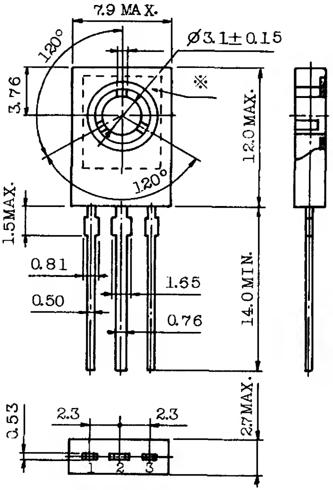
AUDIO FREQUENCY POWER AMPLIFIER

LOW SPEED SWITCHING

FEATURES:

- Suitable for output stage of 5 watts car radio and car stereo.
- Good linearity of h_{FE}.
- Complementary to 2SA1217.

Unit in mm



1. EMITTER
2. COLLECTOR
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

※ The inside metal of dotted line is connected to collector lead. Weight 0.72g

MAXIMUM RATINGS (Ta=25°C)

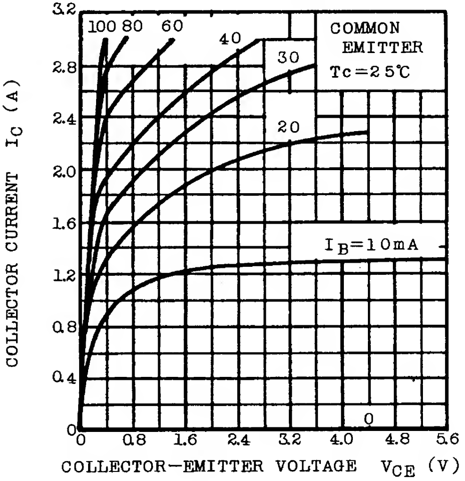
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	40	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

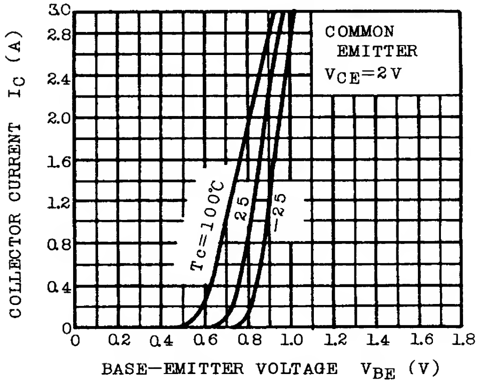
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current	I_{CBO}	V_{CB}=40V, I_E=0	-	-	100	nA
Emitter Cutoff Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	40	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=0.5A	80	-	240	
	$h_{FE(2)}$	V_{CE}=2V, I_C=2.5A	25	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.2A	-	-	0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=0.5A	-	-	1.0	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	35	-	pF

Note: h_{FE} Classification O : 80~160 Y : 120 ~ 240

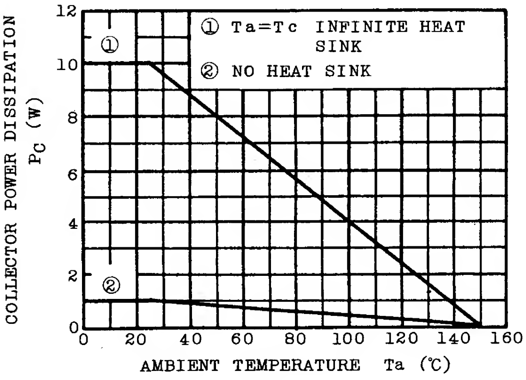
$I_C - V_{CE}$



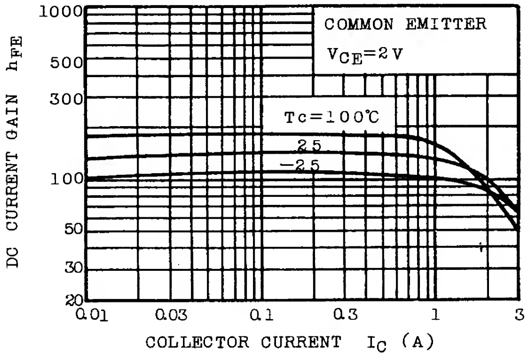
$I_C - V_{BE}$



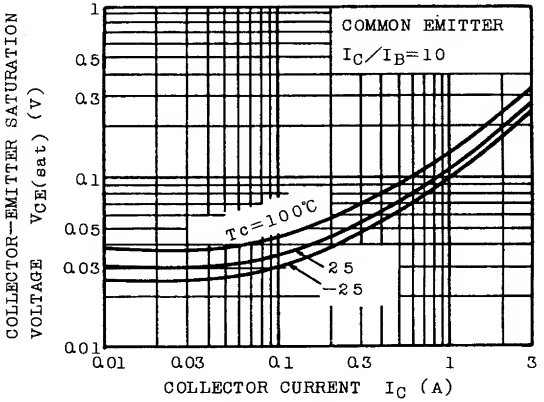
$P_C - T_c$



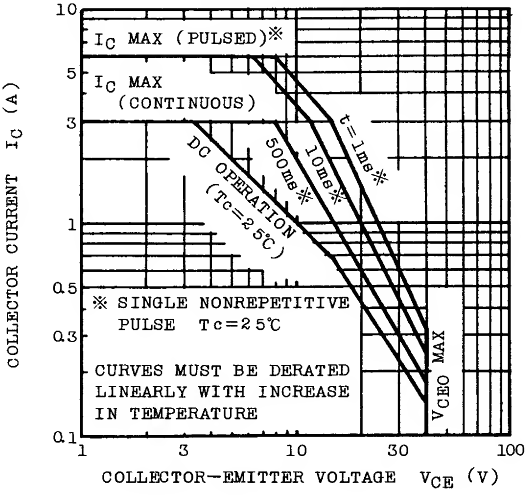
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



SAFE OPERATION AREA

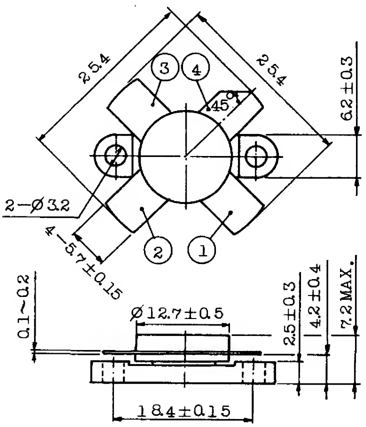


2SC2879

SILICON NPN EPITAXIAL PLANAR TYPE

2～30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	–
EIAJ	–
TOSHIBA	2–13B1A

Weight : 5.2g

FEATURES:

- Specified 12.5V, 28MHz Characteristics
  - : Output Power : P_O=100W$_{PEP}$
  - : Minimum Gain : Gpe=10dB
  - : Efficiency : η_c=35%(Min.)
- Intermodulation Distortion : IMD=-24dB(Max.) (MIL Standard)

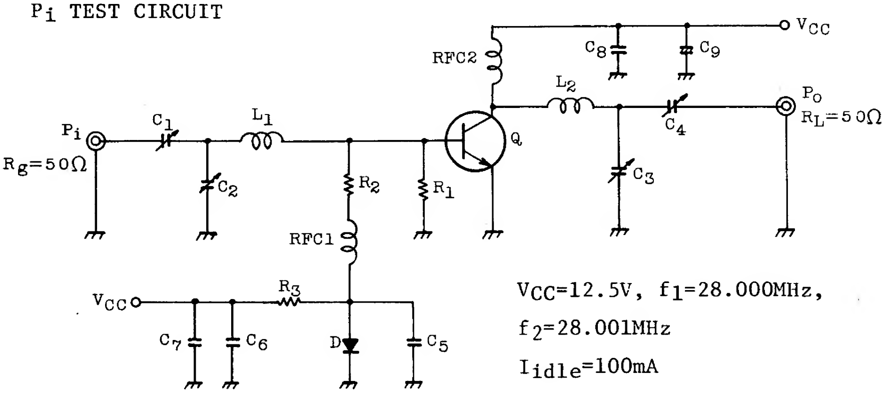
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	45	V
Collector-Emitter Voltage	V_{CES}	45	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	25	A
Collector Power Dissipation (Tc=25°C)	P_C	250	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	I_C=100mA, V_{BE}=0	45	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=1mA, I_C=0	4	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=10A	10	-	150	
Collector Output Capacitance	C_{ob}	V_{CB}=12.5V, I_E=0, f=1MHz	-	700	-	pF
Power Gain	G_{pe}	V_{CC}=12.5V, f=28MHz 2-Tone, Δf=1kHz Iidle=100mA, P_O=100W$_{PEP}$ (Fig.)	13.0	15.2	-	dB
Input Power	P_i		-	6	10	W$_{PEP}$
Collector Efficiency	η_c		35	-	-	%
Intermodulation Distortion	IMD		-	-	-24	dB
Series Equivalent Input Impedance	Z_{IN}	V_{CC}=12.5V, f=28MHz Δf=1kHz, P_O=100W$_{PEP}$	-	1.45 -j0.95	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	1.45 -j1.0	-	Ω

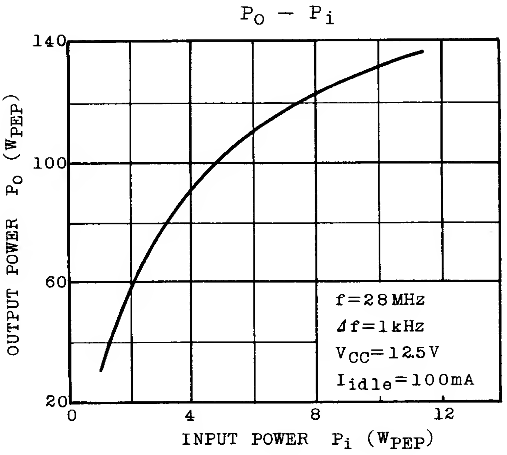
Fig. P_i TEST CIRCUIT

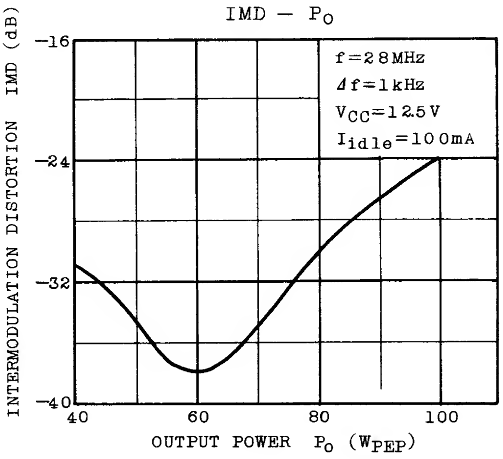


V_{CC}=12.5V, f_1=28.000MHz,
f_2=28.001MHz
I_{idle}=100mA

C_1,C_2 : 7 ~150pF
C_3,C_4 : 7 ~150pF 2KWV
C_5,C_6 : 0.022μF
C_7 : 47μF 10WV
C_8 : 0.044μF
C_9 : 100μF 50WV
Q : 2SC2879

L_1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P
L_2 : ϕ1.2 ENAMEL COATED COPPER WIRE, 14ID, 3½T, 3P
RFC1 : ϕ0.8 ENAMEL COATED COPPER WIRE, 10ID, 9T
(Ferrite Core TDK K2)
RFC2 : ϕ1.8 ENAMEL COATED COPPER WIRE, 14ID, 20T
R_1 : 10Ω(1W)
R_2 : 2Ω(1/2W)
R_3 : 10Ω(5W)
D : 1S1555



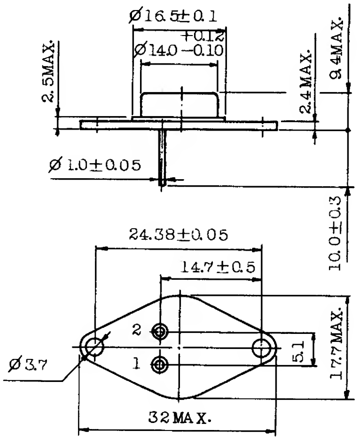


2SC2913

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	―
EIAJ	―
TOSHIBA	2−14A1A

Mounting kit No. AC74
Weight : 7.6g

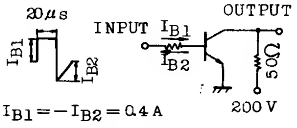
FEATURES:

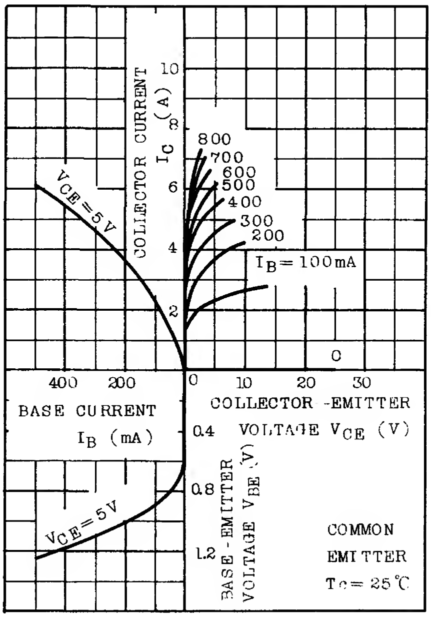
- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=4A
- High Collector Breakdown Voltage : V_{CEO}=400V

MAXIMUM RATINGS (Ta=25°C)

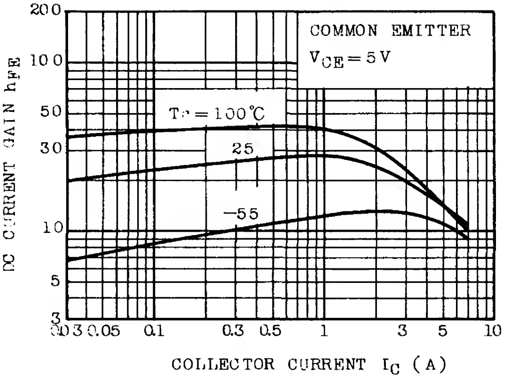
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	7	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

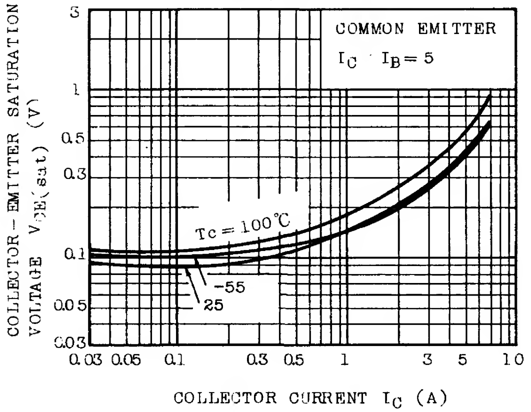
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=3A	12	-	-	
			V_{CE}=5V, I_C=7A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=7A, I_B=1.4A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=7A, I_B=1.4A	-	-	2.0	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 50Ω 200 V $I_{B1}=-I_{B2}$=0.4A DUTY CYCLE<1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	



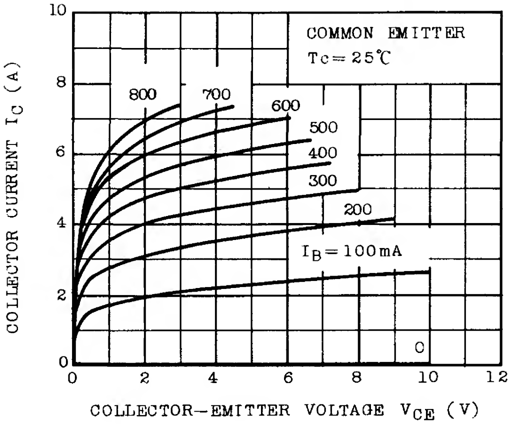
STATIC CHARACTERISTICS



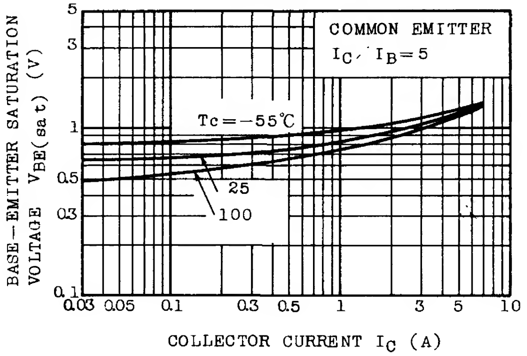
h_{FE} – I_C



$V_{CE(sat)}$ – I_C

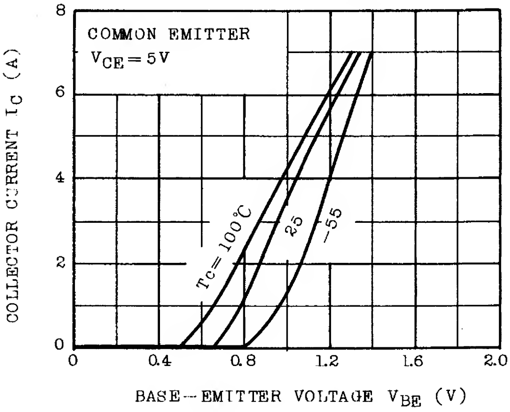


I_C – V_{CE} (LOW VOLTAGE REGION)

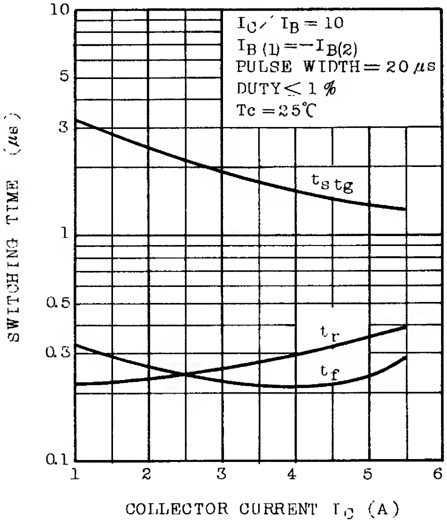


$V_{BE(sat)}$ – I_C

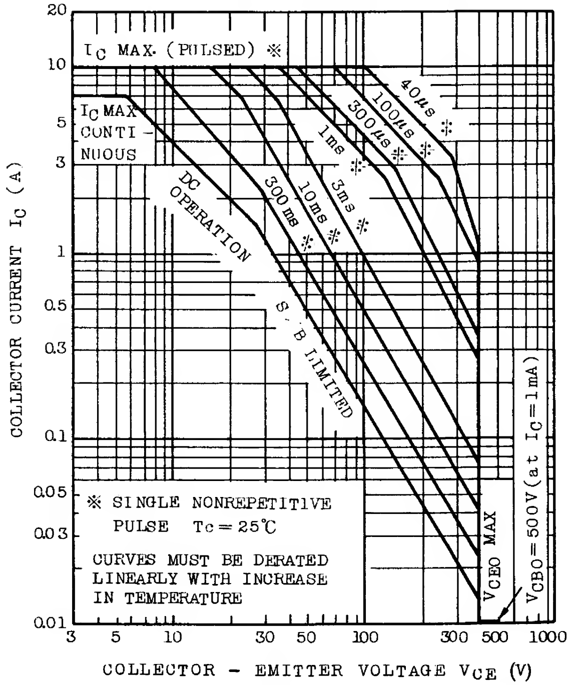
I_C — V_{BE}



SWITCHING CHARACTERISTICS



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

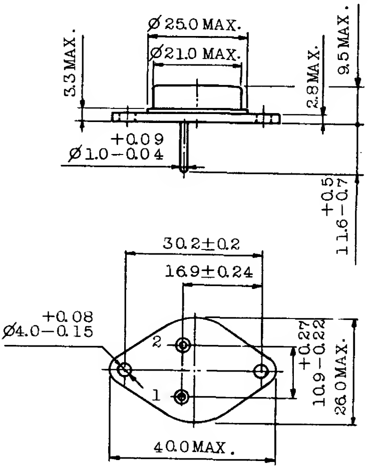
2SC2914

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS. HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=7A
- High Collector Breakdown Voltage : V_{CEO}=400V

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

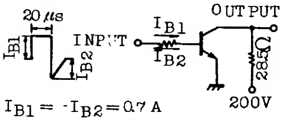
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Mounting kit No. AC73
Weight : 15.3g

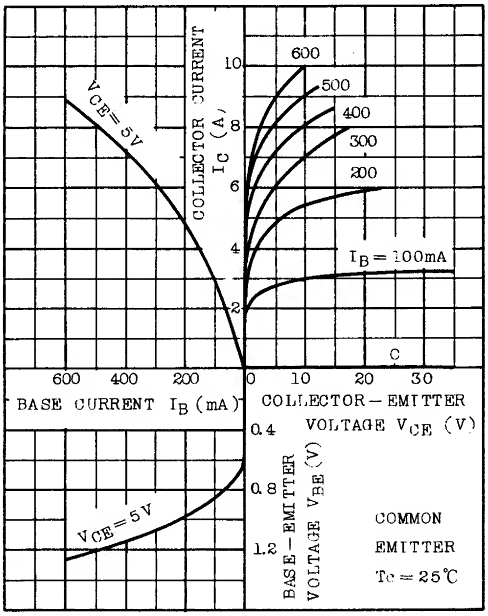
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	10	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

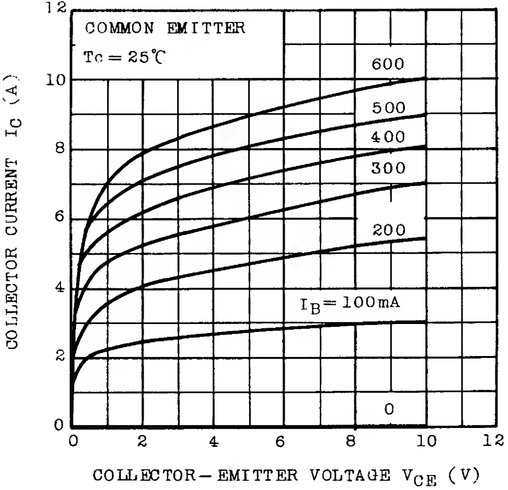
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=5A	12	-	-	
			V_{CE}=5V, I_C=10A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=2A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=2A	-	-	2.0	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 28.5Ω 200V I_{B1} = -I_{B2} = 0.7 A DUTY CYCLE < 1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

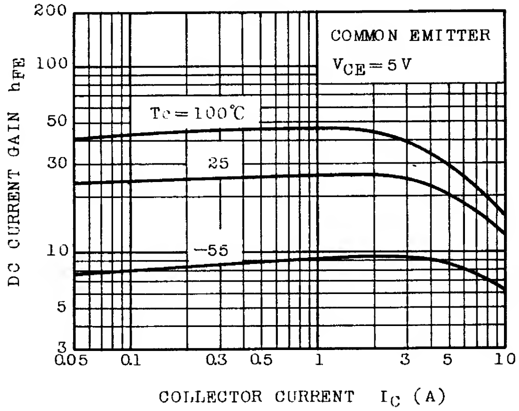
STATIC CHARACTERISTICS



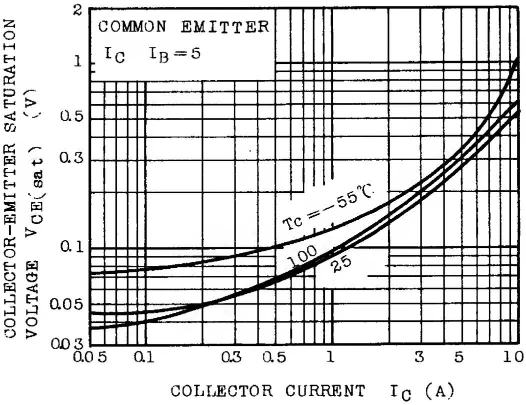
I_C − V_{CE} (LOW VOLTAGE REGION)



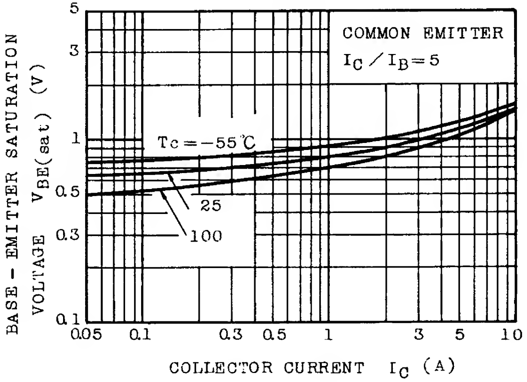
h_{FE} − I_C



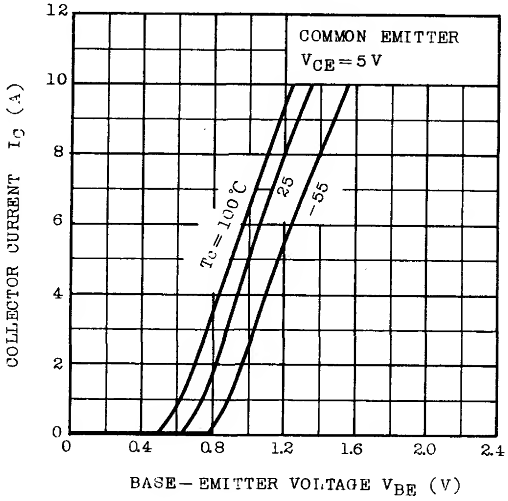
$V_{CE(sat)}$ − I_C



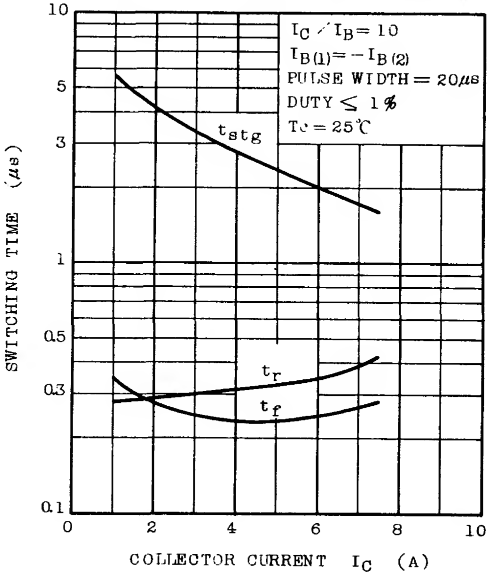
$V_{BE(sat)}$ − I_C



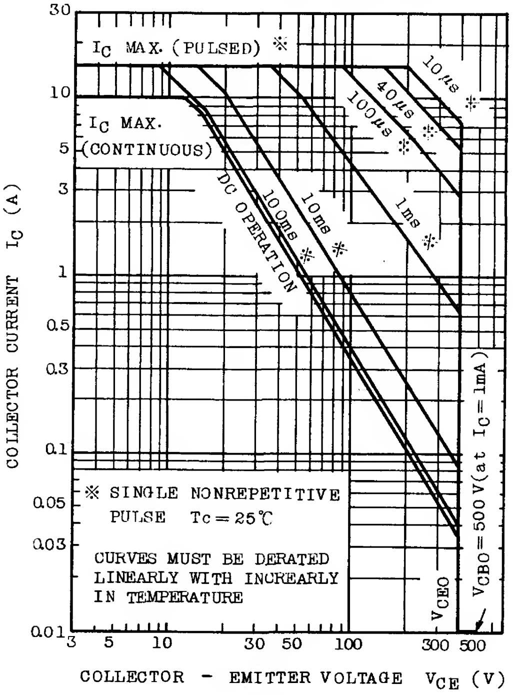
$I_C - V_{BE}$



SWICHING CHARACTERISTICS



SAFE OPERATING AREA



2SC2983

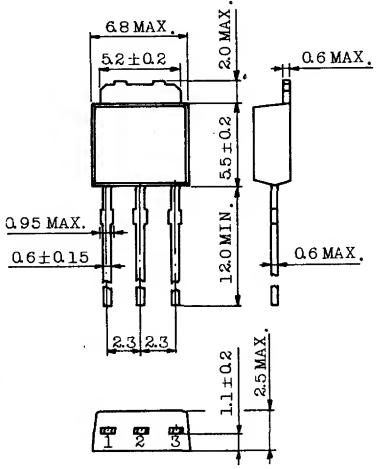
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=100MHz (Typ.)
- Complementary to 2SA1225

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

MAXIMUM RATINGS (Ta=25°C)

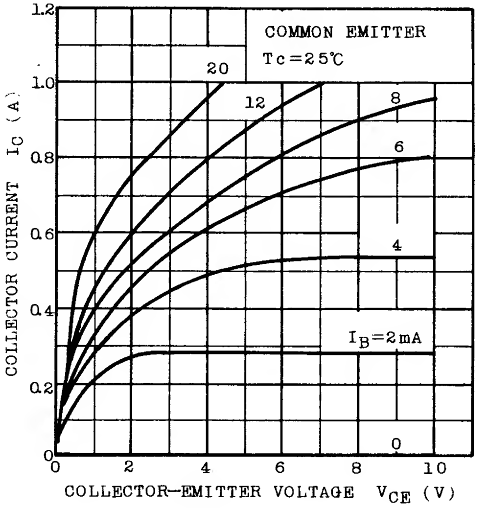
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	160	V
Collector-Emitter Voltage		V_{CEO}	160	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.3	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

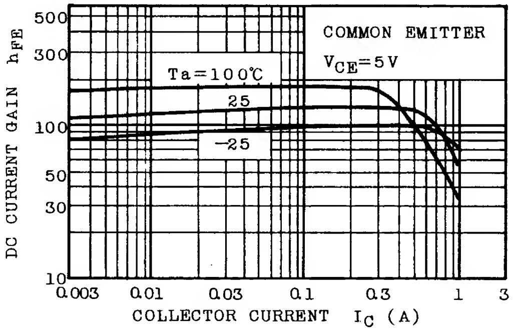
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=160V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	I_C=10mA, I_B=0	160	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=100mA	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=100mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	25	-	pF

Note: h_{FE} Classification O : 70~140, Y : 120~240

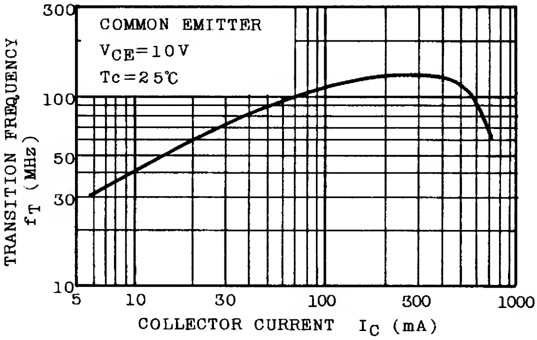
$I_C - V_{CE}$



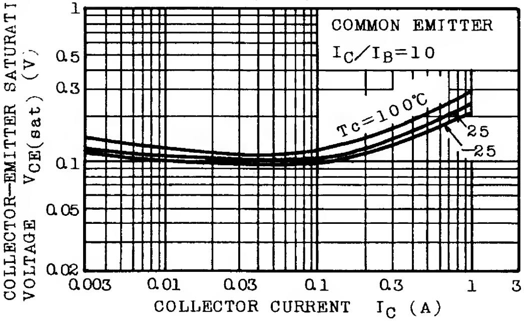
$h_{FE} - I_C$



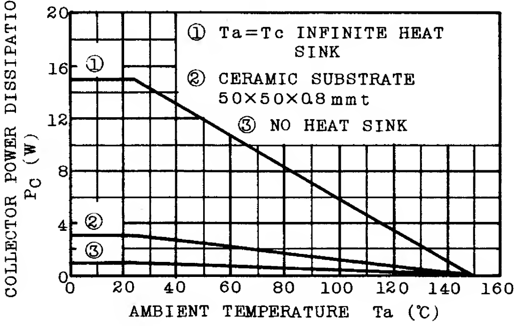
$f_T - I_C$



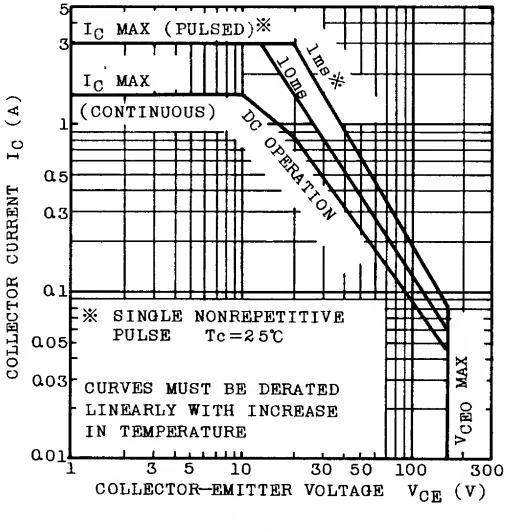
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA

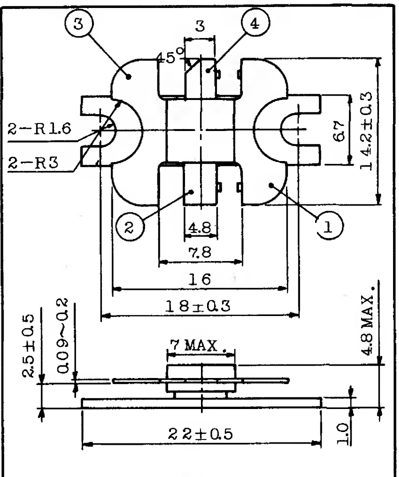


2SC3006

SILICON NPN EPITAXIAL PLANAR TYPE

UHF BAND POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

JEDEC	−
EIAJ	−
TOSHIBA	2−7A1A

Weight : 1.9g

FEATURES:

- Output Power
  : P_O=3W (Min.) (f=470MHz, V_{CC}=12.6V, P_i=0.4W)

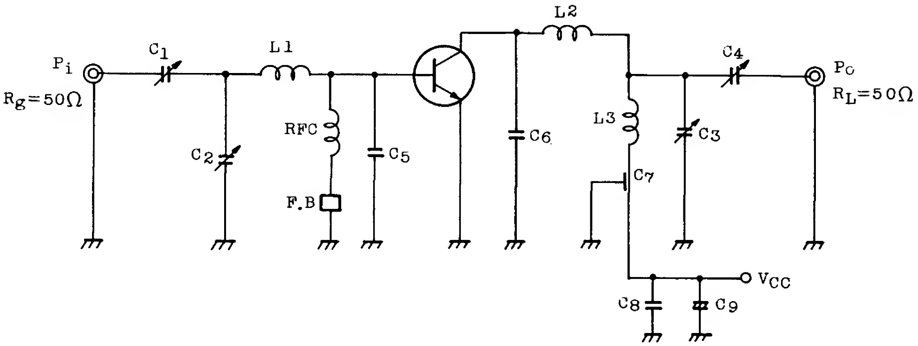
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65～175	°C

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=15V, I_E=0	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=2mA, I_E=0	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=5mA, I_B=0	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=0.1mA, I_C=0	3.5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	10	-	-	-
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	10	-	pF
Output Power	P_o	V_{CC}=12.6V, f=470MHz, P_i=0.4W (Fig.)	3	-	-	W
Power Gain	G_{pe}		8.7	-	-	dB
Collector Efficiency	η_c		50	-	-	%

Fig. f=470MHz P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : ~20pF

C_5, C_6 : 10pF

C_7 : 0.01μF

C_8 : 0.02μF

C_9 : 10μF

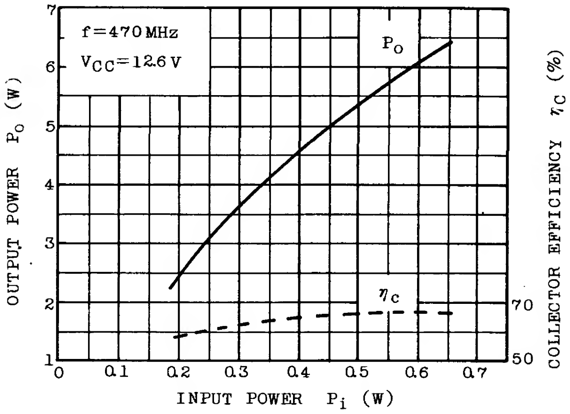
L1,L2 : 5mm × 20mm COPPER PLATE

L3 : ϕ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : ϕ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERRITE BEADS

$P_o, \eta_C - P_i$



2SC3007

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

INDUSTRIAL APPLICATIONS

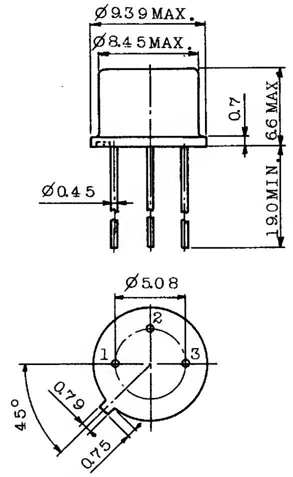
Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.5V$(Max.) at $I_C=1A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

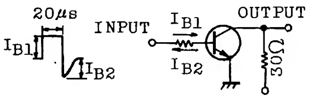
JEDEC	TO-39
EIAJ	TC-5, TB-5B
TOSHIBA	2-8B1A

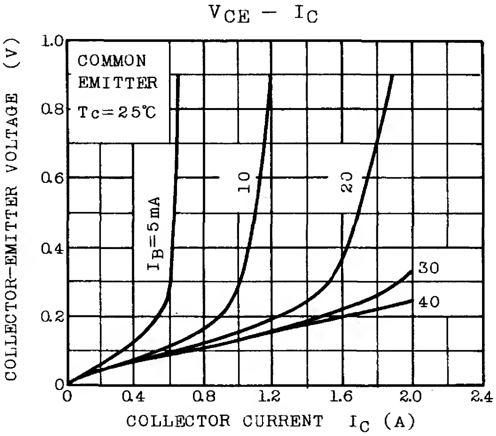
Weight : 1.13g

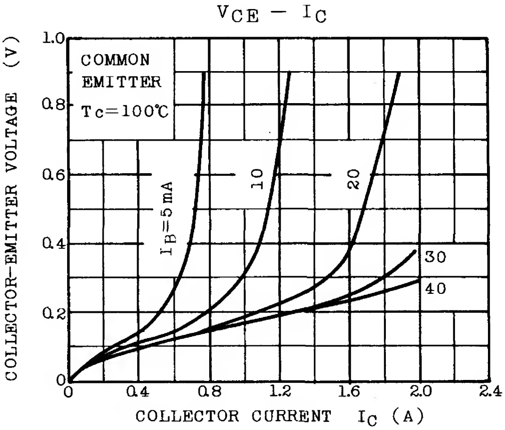
MAXIMUM RATINGS ($Ta=25^\circ C$)

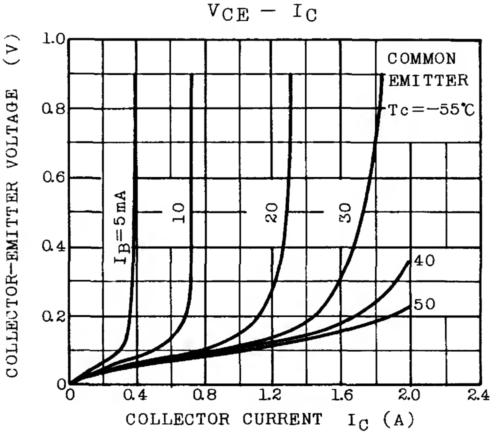
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2	A
Base Current	I_B	0.2	A
Collector Power Dissipation	P_C	800	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

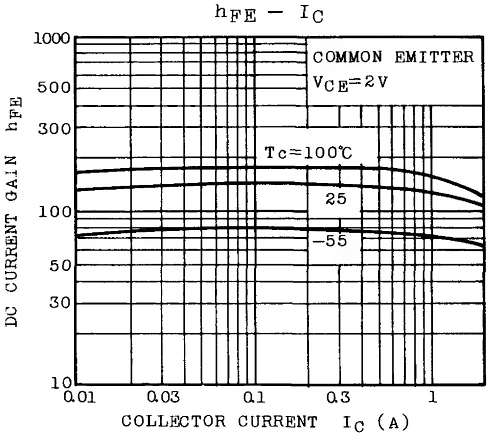
ELECTRICAL CHARACTERISTICS ($Ta=25^\circ C$)

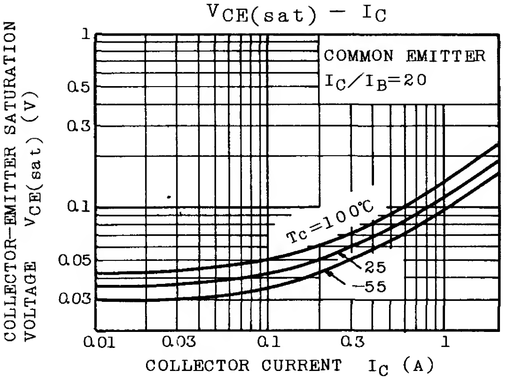
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V$, $I_E=0$	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V$, $I_C=0.5A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=2V$, $I_C=1.5A$	40	-	-	
Saturation Voltage	Base-Emitter	$V_{CE(sat)}$	$I_C=1A$, $I_B=0.05A$	-	-	0.5	V
	Collector-Emitter	$V_{BE(sat)}$	$I_C=1A$, $I_B=0.05A$	-	-	1.2	
Transition Frequency		f_T	$V_{CE}=2V$, $I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	-	30	-	pF
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=-I_{B2}=0.05A$ DUTY CYCLE≦1%	-	0.1	-	μs
	Fall Time	t_{stg}		-	1.0	-	
	Storage Time	t_f		-	0.1	-	

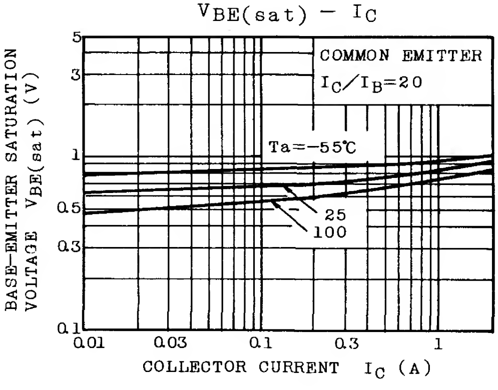

VCE − IC
COMMON
EMITTER
Tc=25℃
COLLECTOR-EMITTER VOLTAGE (V)
1.0
0.8
0.6
0.4
0.2
0
IB=5mA
10
20
30
40
0
0.4
0.8
1.2
1.6
2.0
2.4
COLLECTOR CURRENT IC (A)

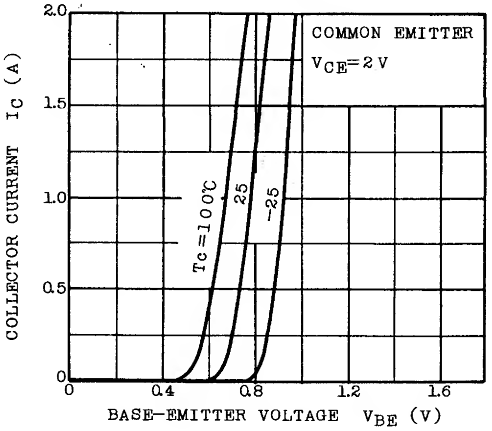

VCE − IC
COMMON
EMITTER
Tc=100℃
COLLECTOR-EMITTER VOLTAGE (V)
1.0
0.8
0.6
0.4
0.2
0
IB=5mA
10
20
30
40
0
0.4
0.8
1.2
1.6
2.0
2.4
COLLECTOR CURRENT IC (A)


VCE − IC
COMMON
EMITTER
Tc=−55℃
COLLECTOR-EMITTER VOLTAGE (V)
1.0
0.8
0.6
0.4
0.2
0
IB=5mA
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2.0
2.4
COLLECTOR CURRENT IC (A)

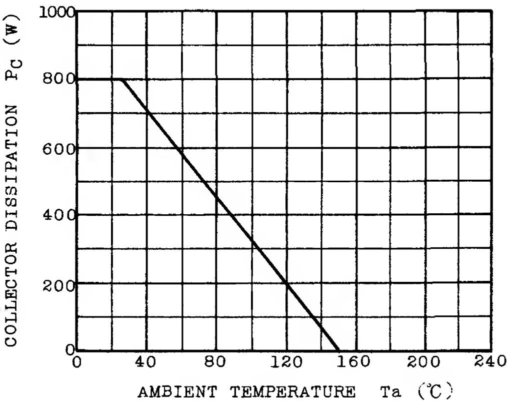

hFE − IC
COMMON EMITTER
VCE=2V
DC CURRENT GAIN hFE
1000
500
300
100
50
30
10
Tc=100℃
25
−55
0.01
0.03
0.1
0.3
1
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC/IB=20
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
1
0.5
0.3
0.1
0.05
0.03
Tc=100℃
25
−55
0.01
0.03
0.1
0.3
1
COLLECTOR CURRENT IC (A)

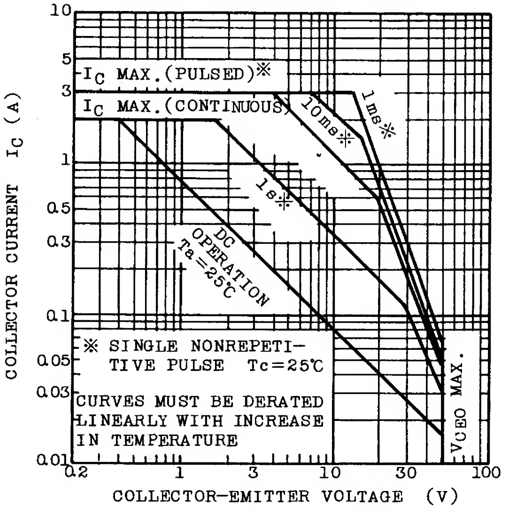

VBE(sat) − IC
COMMON EMITTER
IC/IB=20
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
5
3
1
0.5
0.3
0.1
Ta=−55℃
25
100
0.01
0.03
0.1
0.3
1
COLLECTOR CURRENT IC (A)



I_C – V_{BE}



P_C – Tc



SAFE OPERATING AREA

※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

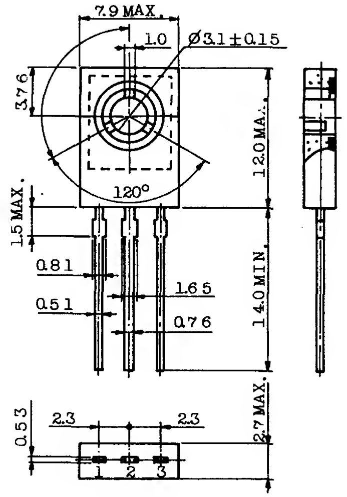
SILICON NPN TRIPLE DIFFUSED TYPE

2SC3051

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

Mounting Kit No. AC46C
Weight : 0.72g

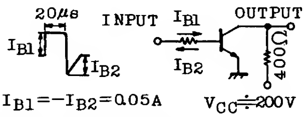
FEATURES:

- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.5μs(Max.) at I_C=0.5A
- High Collector Breakdown Voltage : V_{CEO}=400V

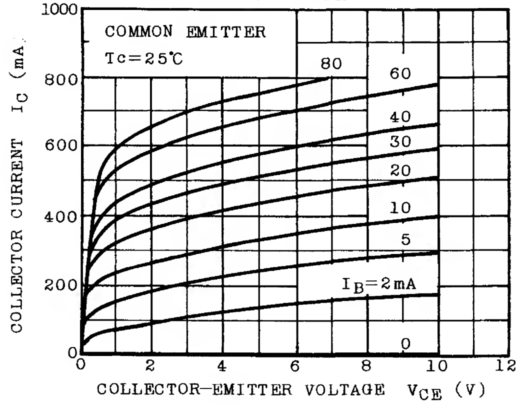
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	0.8	A
	Pulse	I_{CP}	1.5	
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

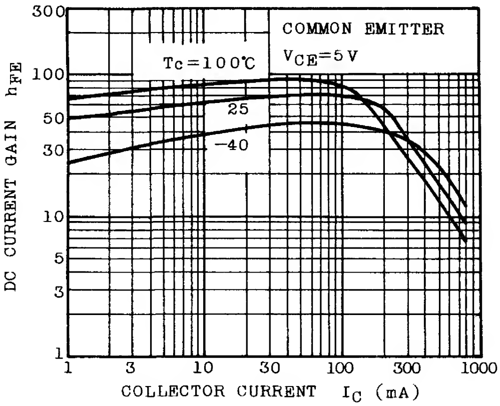
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	100	
			V_{CE}=5V, I_C=0.5A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=0.1A, I_B=0.01A	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=0.1A, I_B=0.01A	-	-	1.0	V
Switching Time	Rise Time	t_r	 20μs INPUT I_{B1} OUTPUT I_{B1} I_{B2} I_{B2} 400Ω V_{CC}≑200V I_{B1}=−I_{B2}=0.05A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.5	

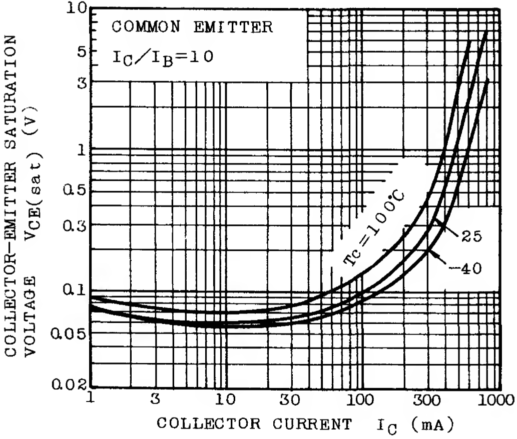
I_C – V_{CE}



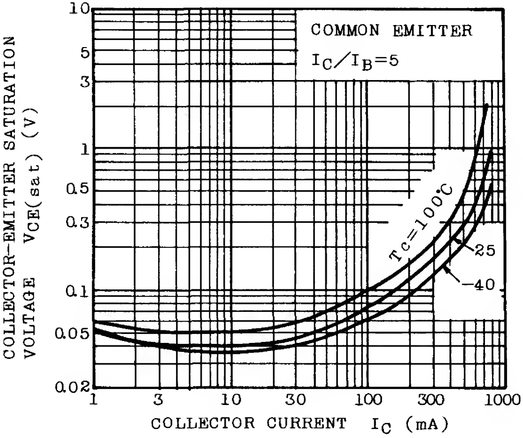
h_{FE} – I_C



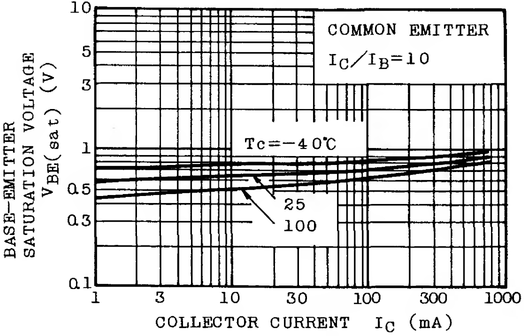
$V_{CE(sat)}$ – I_C



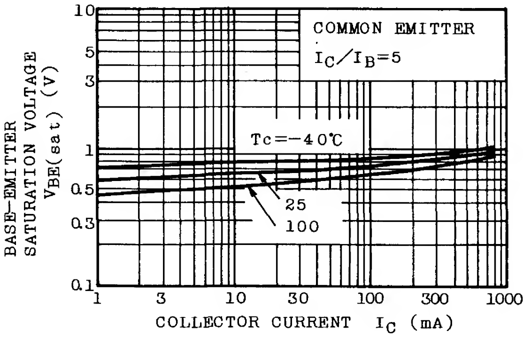
$V_{CE(sat)}$ – I_C



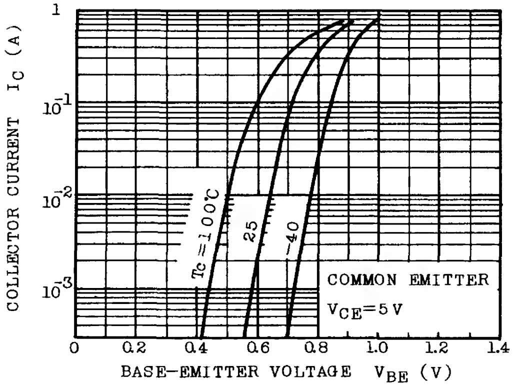
$V_{BE(sat)}$ – I_C



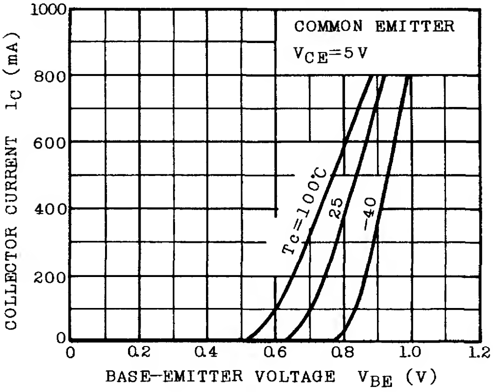
$V_{BE(sat)}$ – I_C



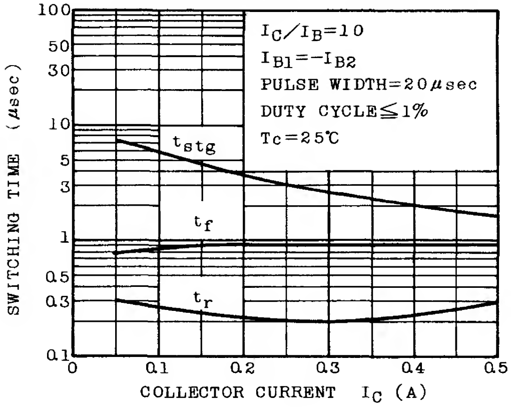
I_C – V_{BE}



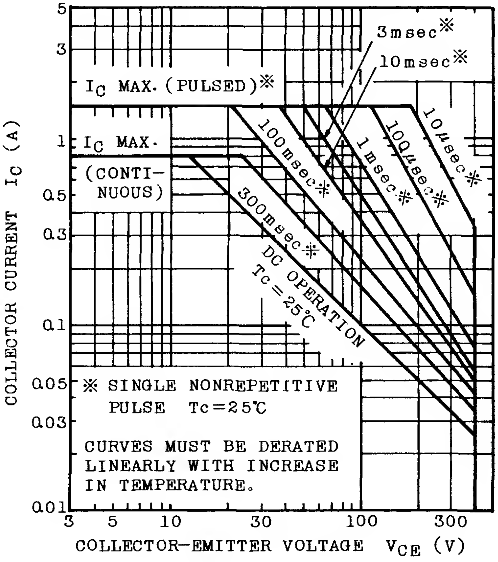
I_C – V_{BE}



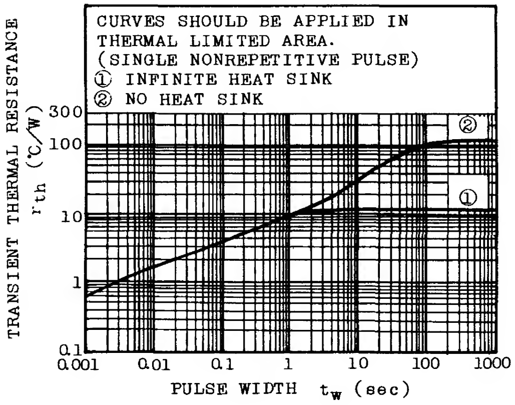
SWITCHING CHARACTERISTICS



SAFE OPERATING AREA



r_{th} – t_w



2SC3072

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

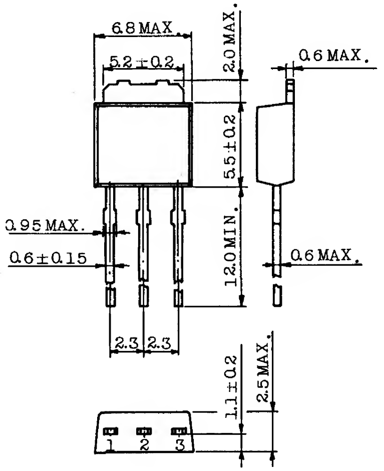
STROBO FLASH APPLICATICNS.

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain: h_{FE}=140~450(V_{CE}=2V, I_C=0.5A)
  h_{FE}=70(Min.) (V_{CE}=2V, I_C=4A)
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=1.0V(Max.) (I_C=4A, I_B=0.1A)
- High Power Dissipation
  : P_C=10W (Tc=25°C), P_C=1.0W (Ta=25°C)

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

Note 1 : Pulse Test:Pulse width =10ms(Max.)
Duty cycle=30%(Max.)

MAXIMUM RATINGS (Ta=25°C)

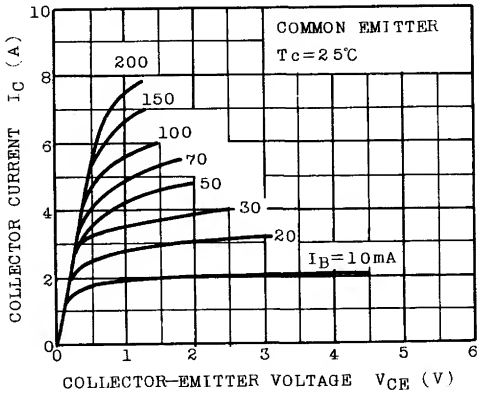
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CES}	40	V
		V_{CEO}	20	
Emitter-Base Voltage		V_{EBO}	8	V
Collector Current	DC	I_C	5	A
	Pulsed (Note 1)	I_{CP}	8	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperautre		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

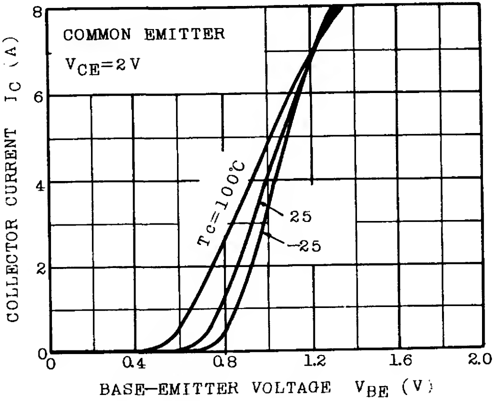
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=40V, I_E=0	-	-	100	nA
Emitter Cut-off Current	I_{EBO}	V_{EB}=8V, I_C=0	-	-	100	nA
Collector-Emitter Breakdown Voltage	V_{CEO}	I_C=10mA, I_B=0	20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	I_E=1mA, I_C=0	8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	V_{CE}=2V, I_C=0.5A	140	-	450	
	$h_{FE(2)}$	V_{CE}=2V, I_C=4A	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.1A	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=4A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	40	-	pF

Note 2 : $h_{FE(1)}$ Clasification A : 140~240, B : 200~330, C : 300~450

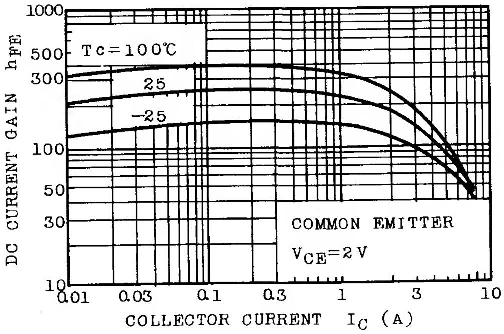
I_C – V_{CE}



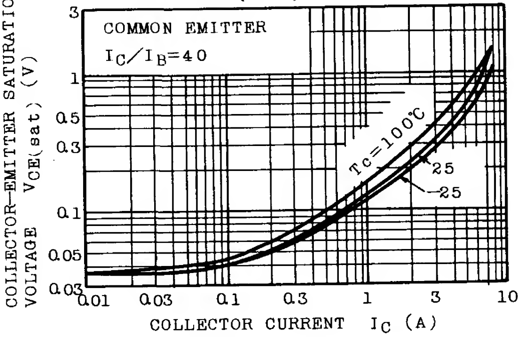
I_C – V_{BE}



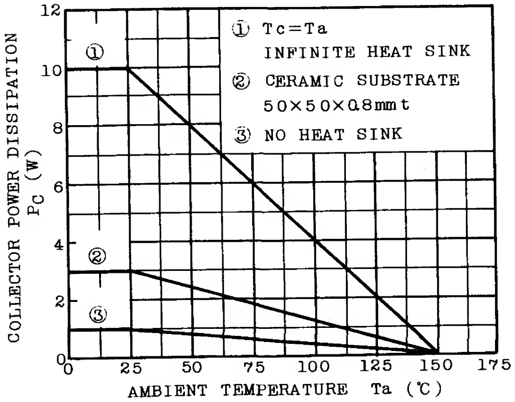
h_{FE} – I_C



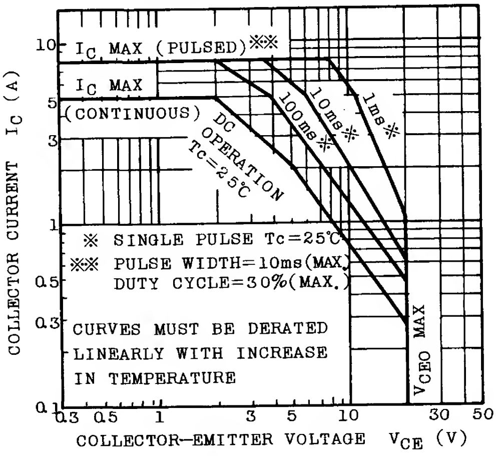
$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



2SC3073

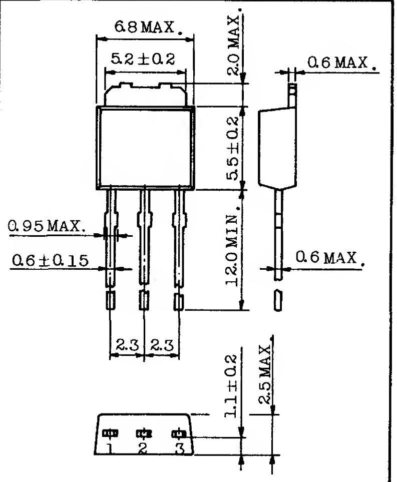
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SA1243

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

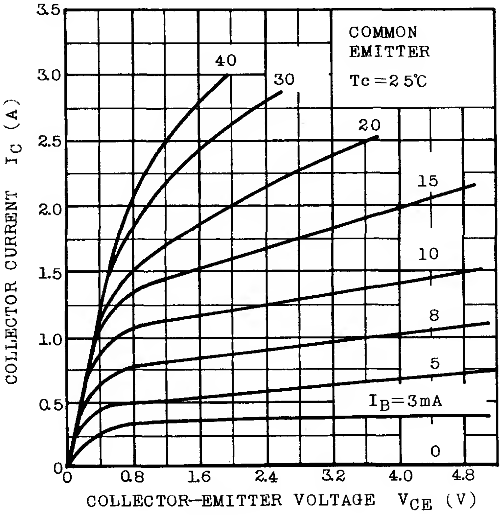
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	30	V
Collector-Emitter Voltage		V_{CEO}	30	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	3	A
Base Current		I_B	0.6	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.0	W
	$T_c=25^{\circ}C$		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

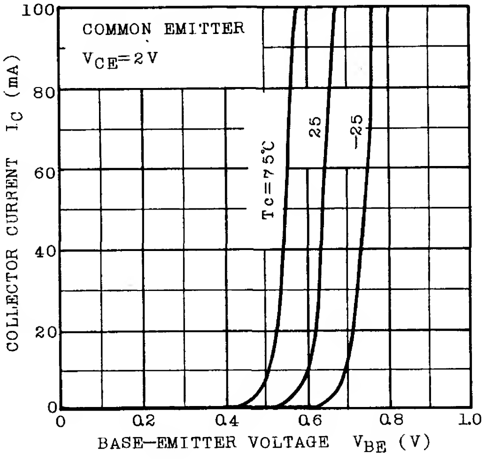
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=20V,\ I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V,\ I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA,\ I_B=0$	30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA,\ I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2V,\ I_C=0.5A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=2V,\ I_C=2.5A$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A,\ I_B=0.2A$	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2V,\ I_C=0.5A$	-	0.75	1.0	V
Transition Frequency	f_T	$V_{CE}=2V,\ I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V,\ I_E=0,\ f=1MHz$	-	35	-	pF

Note: $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

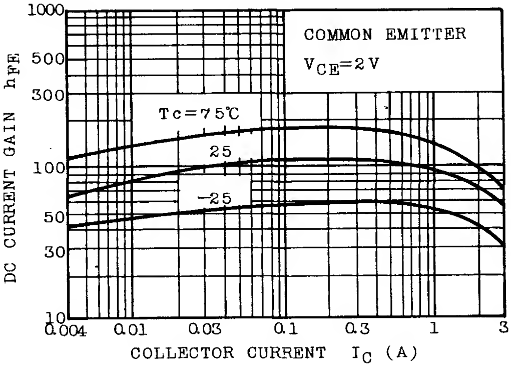
$I_C - V_{CE}$



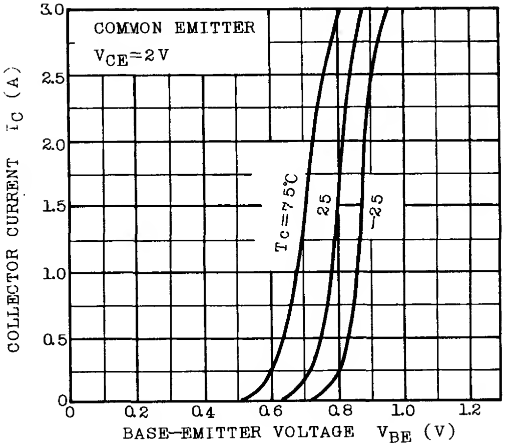
$I_C - V_{BE}$ (LOW CURRENT REGION)



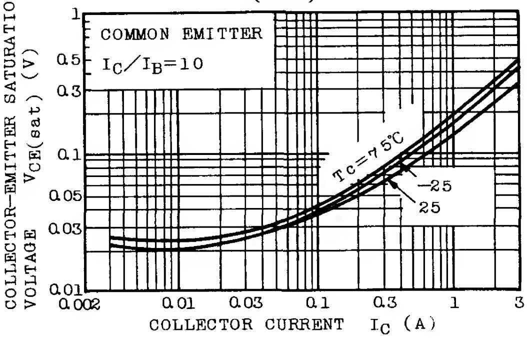
$h_{FE} - I_C$

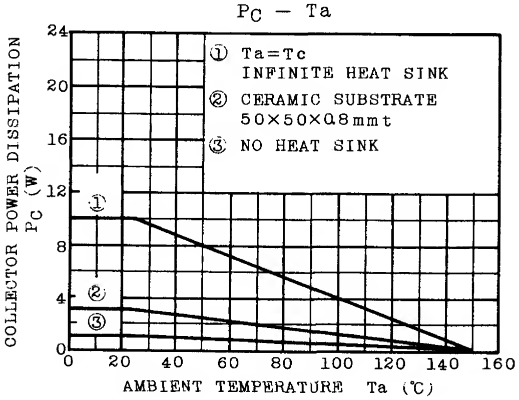


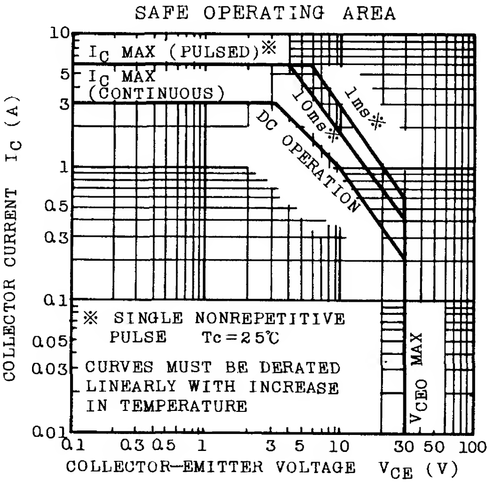
$I_C - V_{BE}$



$V_{CE(sat)} - I_C$




PC — Ta
COLLECTOR POWER DISSIPATION PC (W)
AMBIENT TEMPERATURE Ta (℃)
0
4
8
12
16
20
24
20
40
60
80
100
120
140
160
① Ta=Tc INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
COLLECTOR—EMITTER VOLTAGE VCE (V)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.1
0.3
0.5
1
3
5
10
30
50
100
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3074

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

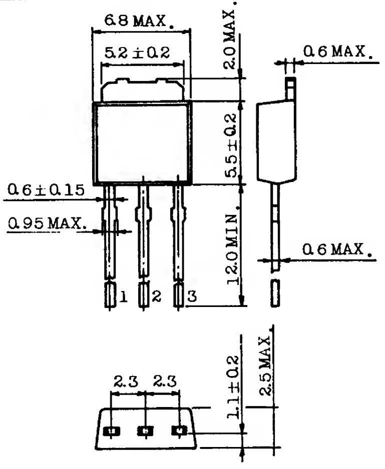
. Low Collector Saturation Voltage

: $V_{CE(sat)}$=0.4V(Max.) (at I_C=3A)

. High Speed Switching Time : t_{stg}=1.0μs(Typ.)

. Complementary to 2SA1244

Unit in mm



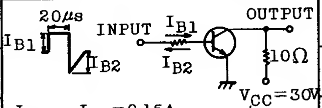
1. BASE
2. COLLECTOR (Fin)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−7B1A

Weight : 0.36g

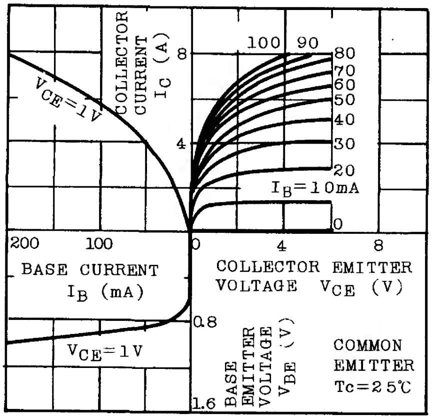
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	5	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

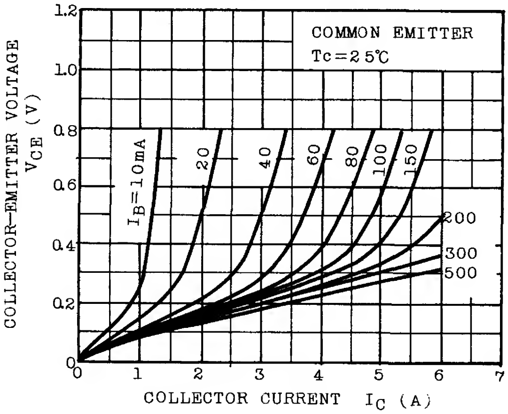
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	−	−	1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	−	−	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	−	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=3A	30	−	−	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=0.15A	−	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=3A, I_B=0.15A	−	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	−	120	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	80	−	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT IB1 IB2 IB1 IB2 OUTPUT 10Ω VCC=30V	−	0.1	−	μs
	Storage Time	t_{stg}		−	1.0	−	
	Fall Time	t_f	I_{B1}=−I_{B2}=0.15A DUTY CYCLE≦1%	−	0.1	−	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

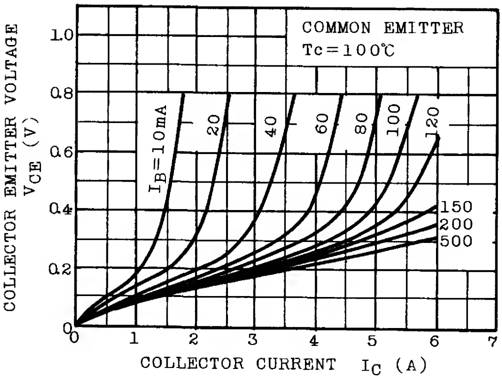
STATIC CHARACTERISTICS



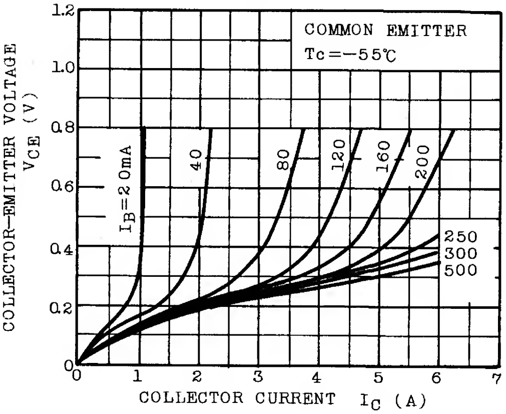
V_{CE} – I_C



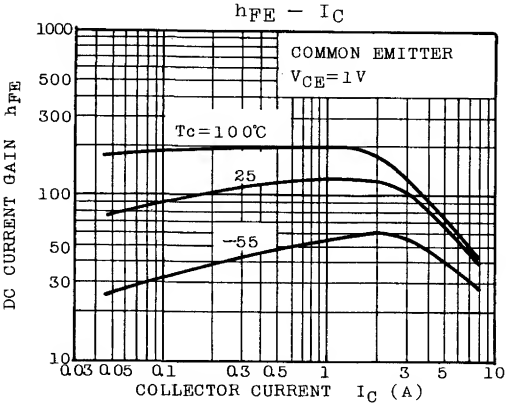
V_{CE} – I_C



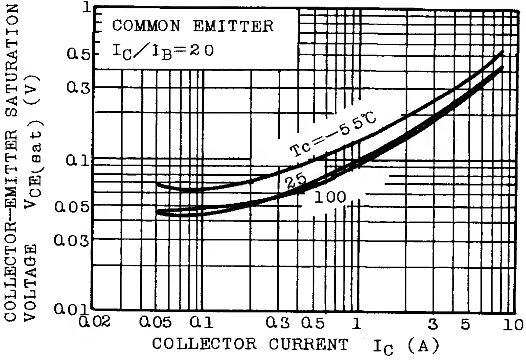
V_{CE} – I_C

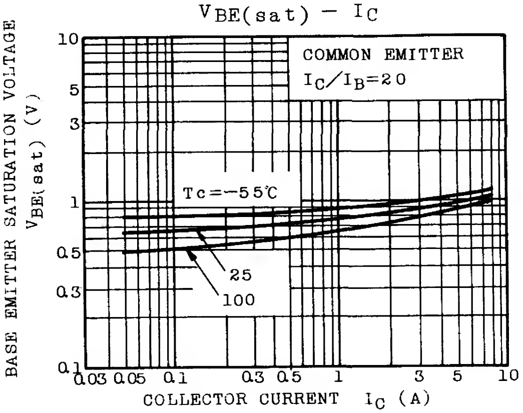


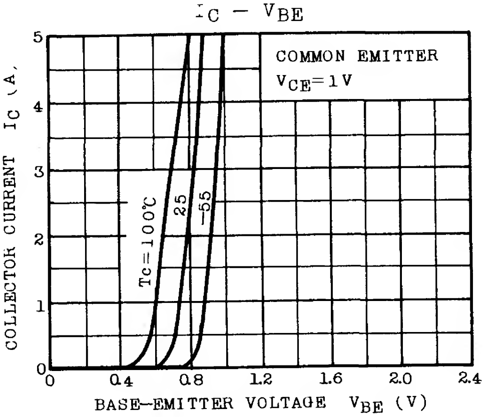
h_{FE} – I_C

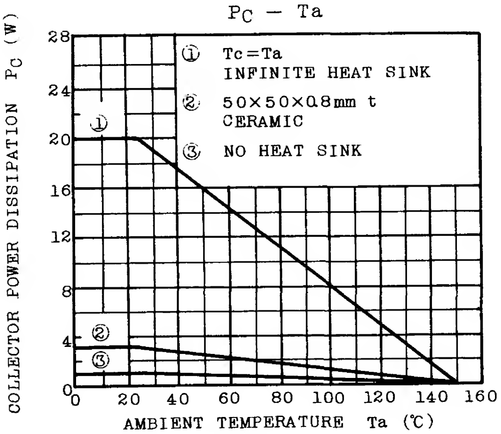


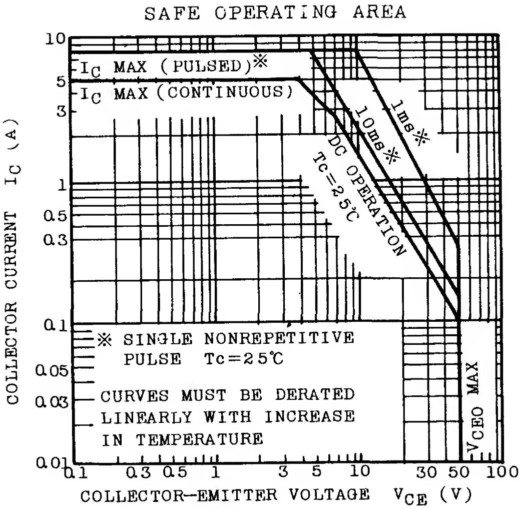
$V_{CE(sat)}$ – I_C




VBE(sat) – IC
COMMON EMITTER
IC/IB=20
Tc=−55℃
25
100
BASE EMITTER SATURATION VOLTAGE VBE(sat) (V)
10
5
3
1
0.5
0.3
0.1
0.03 0.05 0.1 0.3 0.5 1 3 5 10
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=1V
Tc=100℃
25
−55
COLLECTOR CURRENT IC (A)
5
4
3
2
1
0
0 0.4 0.8 1.2 1.6 2.0 2.4
BASE–EMITTER VOLTAGE VBE (V)


PC – Ta
① Tc=Ta
INFINITE HEAT SINK
② 50×50×0.8mm t
CERAMIC
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
28
24
20
16
12
8
4
0
0 20 40 60 80 100 120 140 160
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE
PULSE Tc=25℃
CURVES MUST BE DERATED
LINEARLY WITH INCREASE
IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.1 0.3 0.5 1 3 5 10 30 50 100
COLLECTOR–EMITTER VOLTAGE VCE (V)

2SC3075

SILICON NPN TRIPLE DIFFUSED TYPE

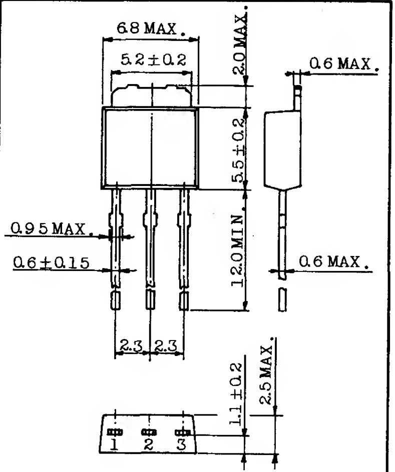
SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.5μs(Max.) at I_C=0.5A
- High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

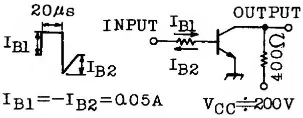
JEDEC	―
EIAJ	―
TOSHIBA	2-7B1A

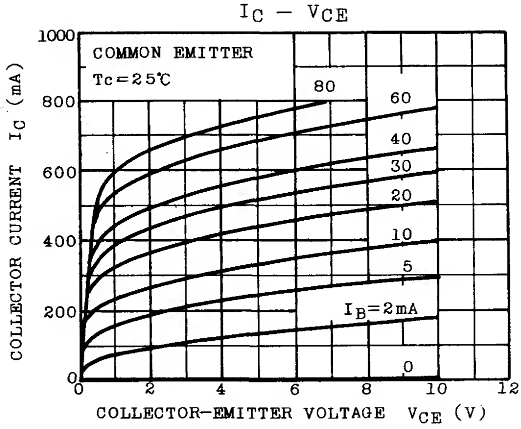
Weight : 0.36g

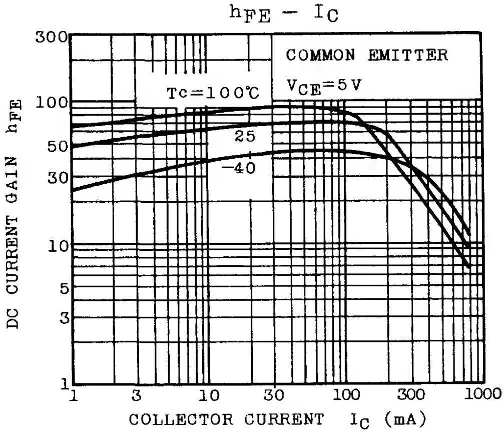
MAXIMUM RATINGS (Ta=25°C)

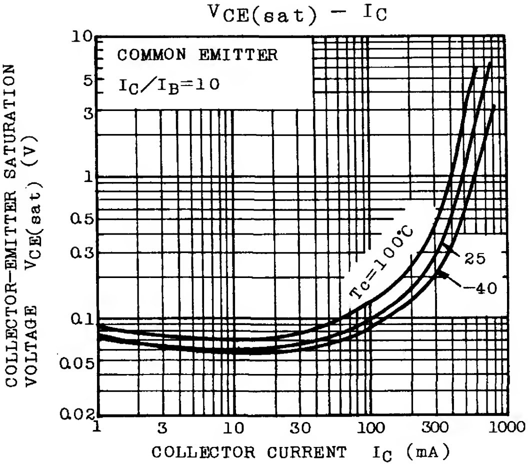
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	0.8	A
	Pulse	I_{CP}	1.5	
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

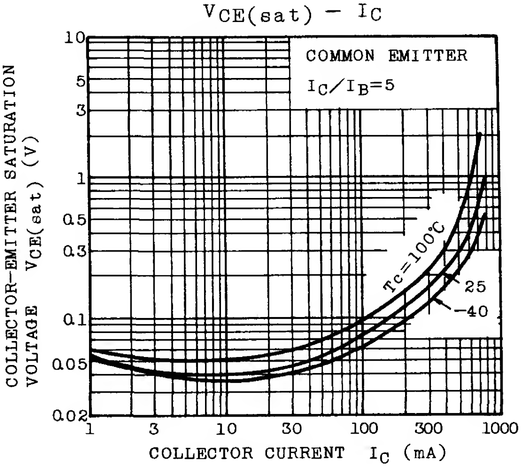
ELECTRICAL CHARACTERISTICS (Ta=25°C)

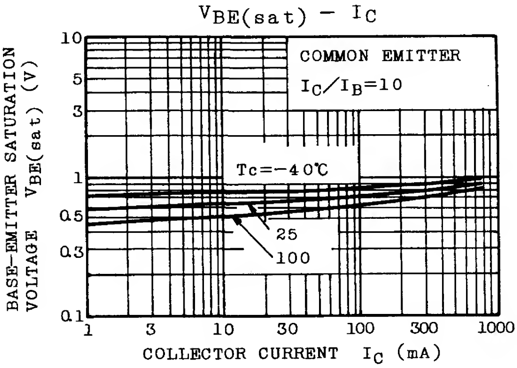
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	100	
			V_{CE}=5V, I_C=0.5A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=0.1A, I_B=0.01A	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=0.1A, I_B=0.01A	-	-	1.0	V
Switching Time	Rise Time	t_r	 20μs INPUT OUTPUT I_{B1} I_{B2} I_{B1} I_{B2} 400Ω V_{CC}≑200V I_{B1}=−I_{B2}=0.05A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.5	

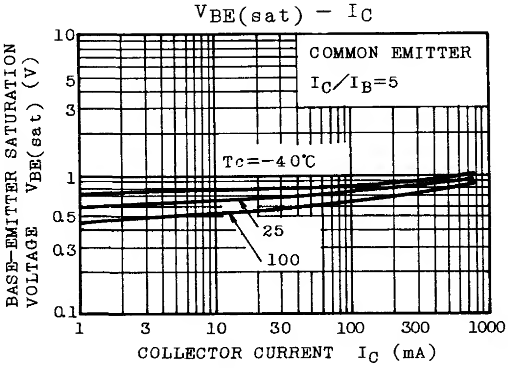

$I_C - V_{CE}$
COMMON EMITTER
Tc=25℃
80
60
40
30
20
10
5
I_B=2mA
0
COLLECTOR CURRENT I_C (mA)
0
200
400
600
800
1000
0
2
4
6
8
10
12
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


$h_{FE} - I_C$
COMMON EMITTER
V_{CE}=5V
Tc=100℃
25
−40
DC CURRENT GAIN h_{FE}
1
3
5
10
30
50
100
300
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (mA)

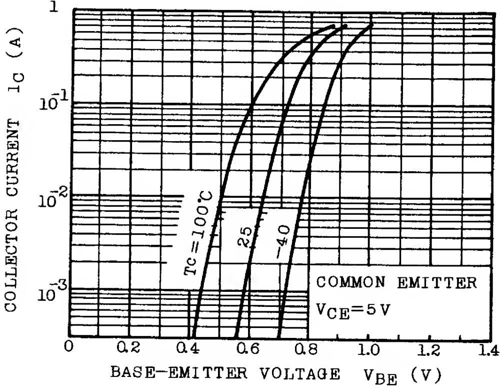

$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=10
Tc=100℃
25
−40
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0.02
0.05
0.1
0.3
0.5
1
3
5
10
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=5
Tc=100℃
25
−40
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0.02
0.05
0.1
0.3
0.5
1
3
5
10
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (mA)

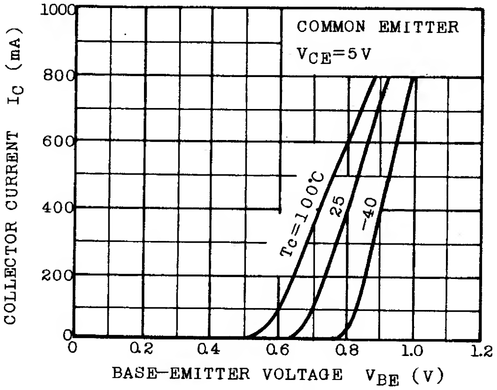

$V_{BE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=10
Tc=−40℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
0.1
0.3
0.5
1
3
5
10
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (mA)


$V_{BE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=5
Tc=−40℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
0.1
0.3
0.5
1
3
5
10
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (mA)

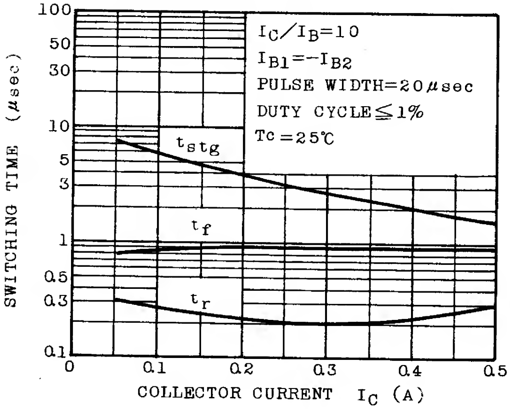
$I_C - V_{BE}$



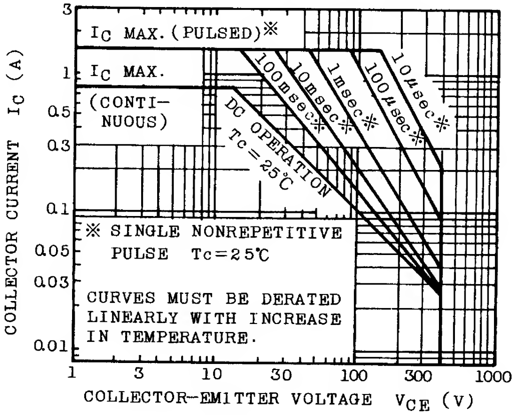
$I_C - V_{BE}$



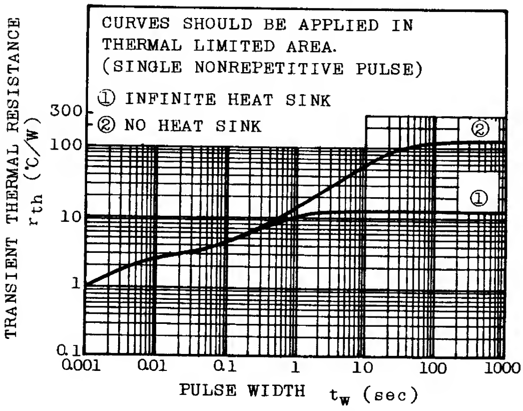
SWITCHING CHARACTERISTICS



SAFE OPERATING AREA



$r_{th} - t_w$



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3076

POWER AMPLIFIER APPLICATIONS.
POWER SWITCHING APPLICATIONS.

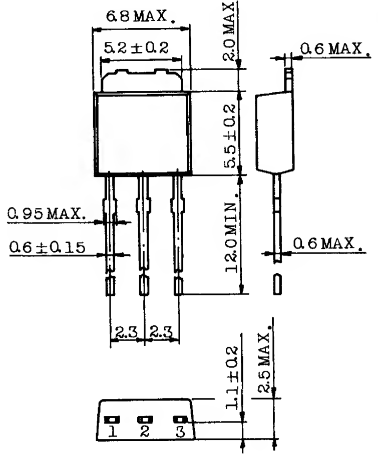
FEATURES:

. Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.5V (Max.) (I_C=1A)

. Excellent Switching Time : t_{stg}=1.0μs (Typ.)

. Complementary to 2SA1241

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

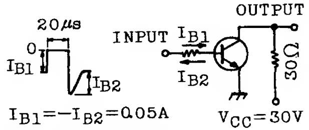
JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

MAXIMUM RATINGS (Ta=25°C)

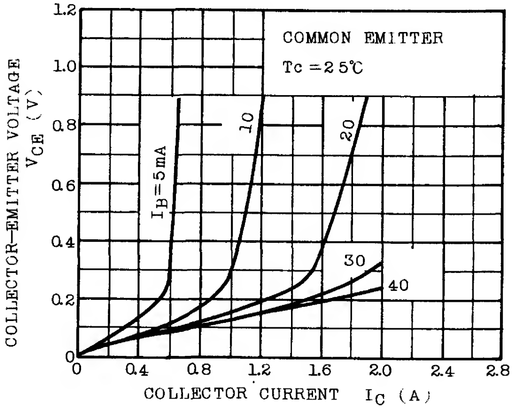
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	2	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature		Tstg	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

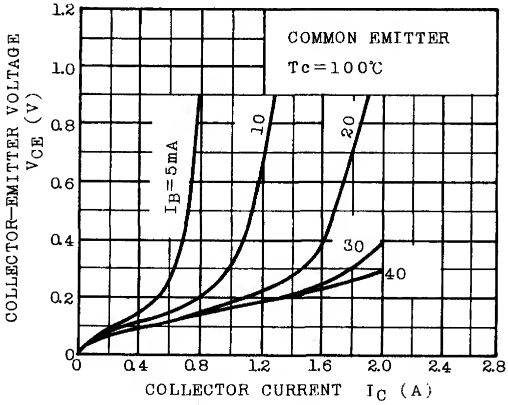
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=0.5A	70	-	240	
		$h_{FE(2)}$	V_{CE}=2V, I_C=1.5A	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.05A	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=0.05A	-	-	1.2	V
Transition Frequency		f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance		Cob	V_{CB}=10V, I_E=0, f=1MHz	-	30	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=−I_{B2}=0.05A DUTY CYCLE≤1% V_{CC}=30V	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~140

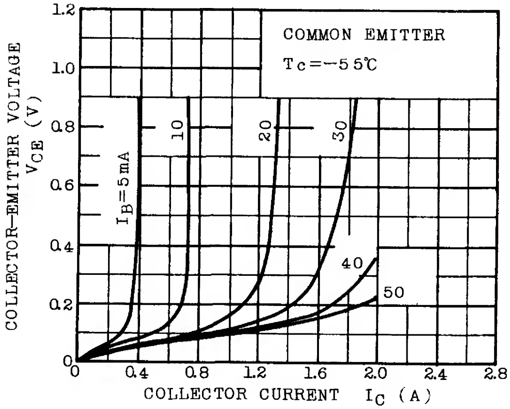
$V_{CE} - I_C$



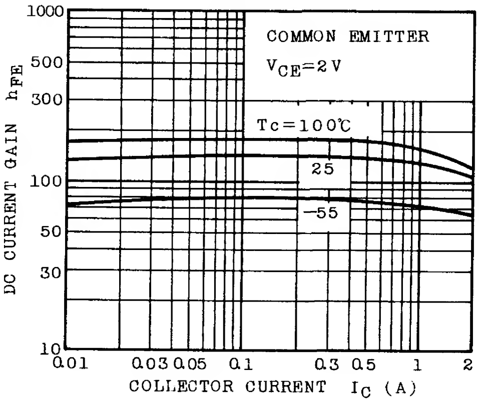
$V_{CE} - I_C$



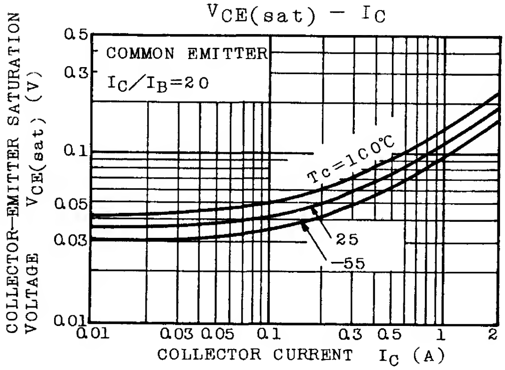
$V_{CE} - I_C$



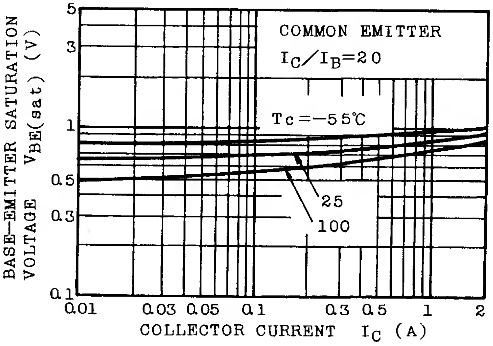
$h_{FE} - I_C$

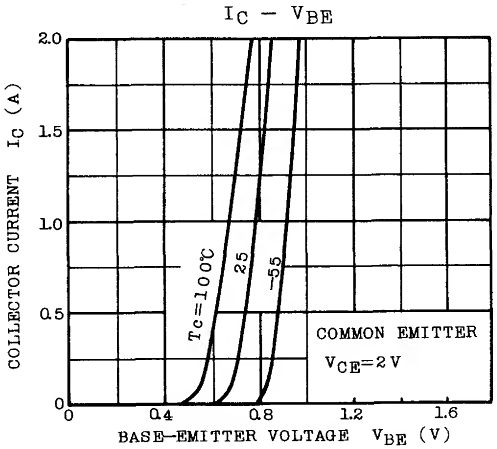


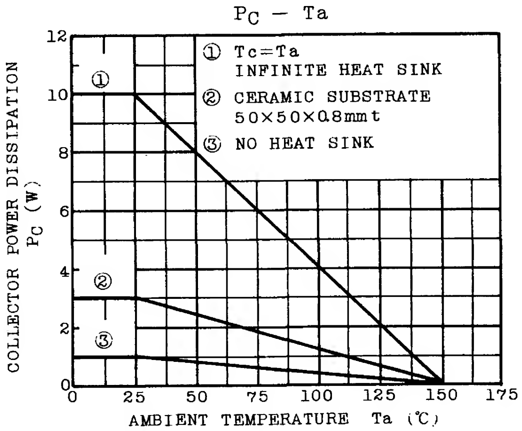
$V_{CE(sat)} - I_C$

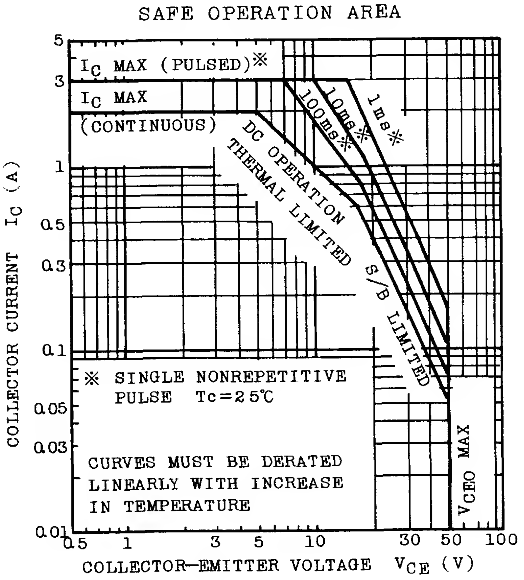


$V_{BE(sat)} - I_C$




I_C – V_{BE}
COLLECTOR CURRENT I_C (A)
2.0
1.5
1.0
0.5
0
0
0.4
0.8
1.2
1.6
BASE–EMITTER VOLTAGE V_{BE} (V)
Tc=100℃
25
−55
COMMON EMITTER
V_{CE}=2V


P_C – Ta
COLLECTOR POWER DISSIPATION P_C (W)
12
10
8
6
4
2
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③

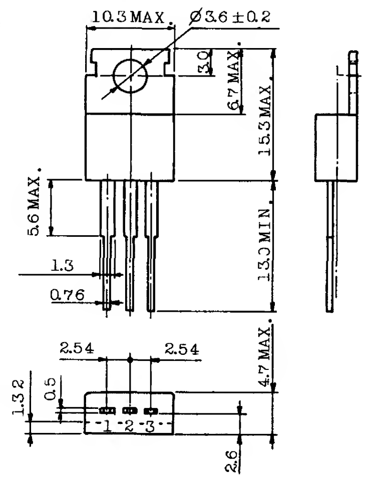

SAFE OPERATION AREA
COLLECTOR CURRENT I_C (A)
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.5
1
3
5
10
30
50
100
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
I_C MAX (PULSED)※
I_C MAX (CONTINUOUS)
DC OPERATION
THERMAL LIMITED
100ms※
10ms※
1ms※
S/B LIMITED
V_{CEO} MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

2SC3148

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE.
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Weight : 1.9g

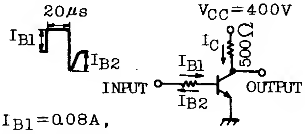
FEATURES:

- Excellent Switching Times (I_C=0.8A)
  t_r=1.0μs Max., t_f=1.0μs Max.
- High Collector-Emitter Breakdwon Voltage : V_{CEO}=800V

MAXIMUM RATINGS (Ta=25°C)

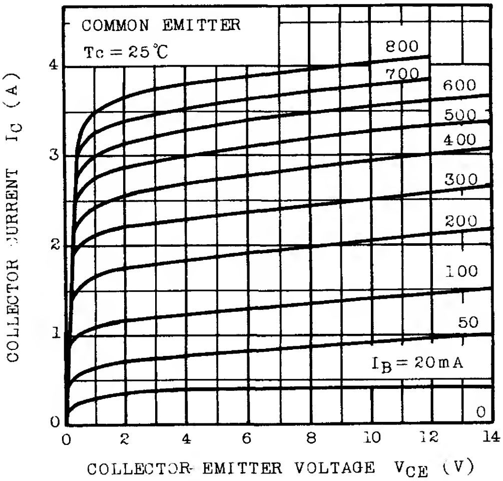
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	3	A
	Peak	I_{CP}	5	
Base Current		I_B	1	A
Collector Power Dissipation (Tc=25°C)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

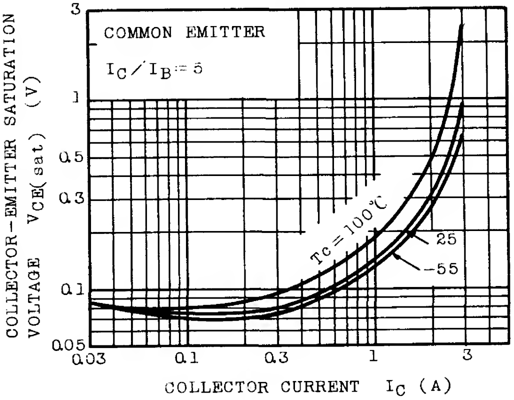
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
DC Current Gain (Note)		h_{FE}	V_{CE}=5V, I_C=0.8A	10	-	-	-
Collector-Emitter Saturation Voltage (Note)		$V_{CE(sat)}$	I_C=0.8A, I_B=0.16A	-	-	0.6	V
Base-Emitter Saturation Voltage (Note)		$V_{BE(sat)}$	I_C=0.8A, I_B=0.16A	-	-	1.2	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} V_{CC}=400V I_C 500Ω I_{B1} INPUT OUTPUT I_{B2} I_{B1}=0.08A, I_{B2}=−0.20A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

Note : Pulse Test:Pulse Width ≦300μs, Duty Cycle≦2%

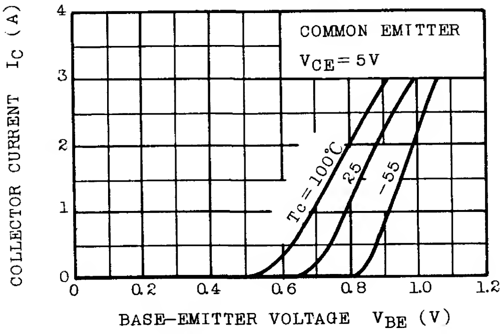
I_C – V_{CE}



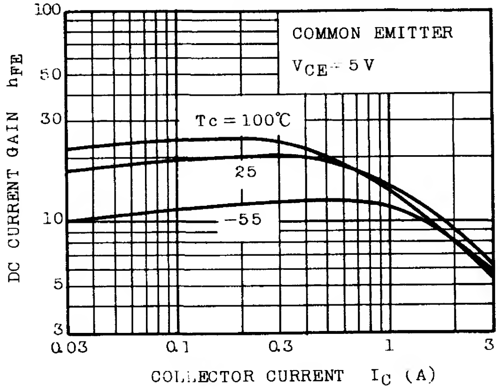
$V_{CE(sat)}$ – I_C



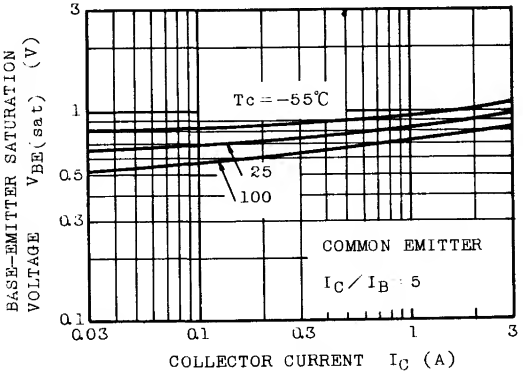
I_C – V_{BE}



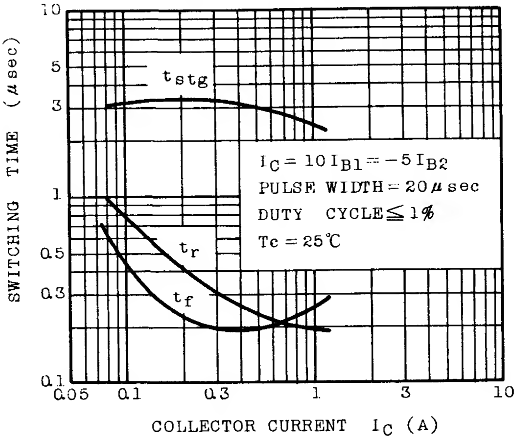
h_{FE} – I_C

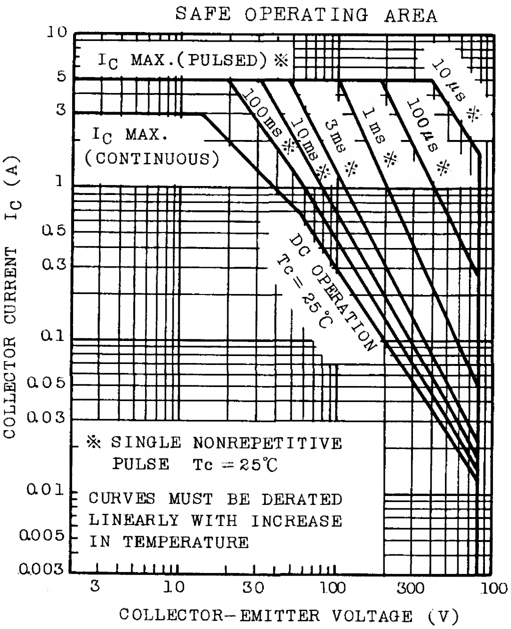


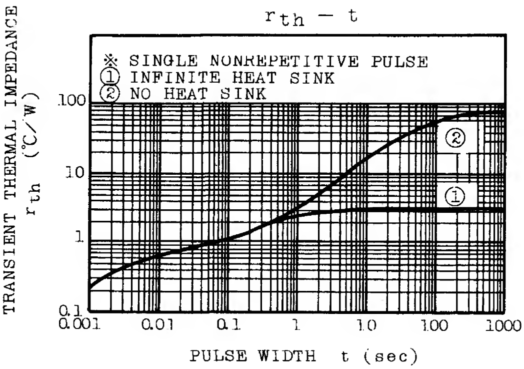
$V_{BE(sat)}$ – I_C

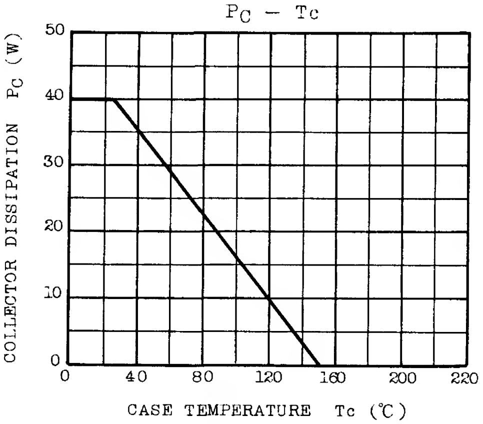


SWITCHING TIME – I_C




SAFE OPERATING AREA
IC MAX.(PULSED) ※
IC MAX.
(CONTINUOUS)
10 μs ※
100 μs ※
1 ms ※
3 ms ※
10ms ※
100ms ※
DC OPERATION
Tc = 25°C
※ SINGLE NONREPETITIVE
PULSE Tc = 25℃
CURVES MUST BE DERATED
LINEARLY WITH INCREASE
IN TEMPERATURE
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.005
0.003
3
10
30
100
300
100
COLLECTOR-EMITTER VOLTAGE (V)


rth – t
※ SINGLE NONREPETITIVE PULSE
① INFINITE HEAT SINK
② NO HEAT SINK
②
①
TRANSIENT THERMAL IMPEDANCE
rth (℃/W)
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
PULSE WIDTH t (sec)


PC – Tc
COLLECTOR DISSIPATION PC (W)
50
40
30
20
10
0
0
40
80
120
160
200
220
CASE TEMPERATURE Tc (℃)

SILICON NPN TRIPLE DIFFUSED TYPE

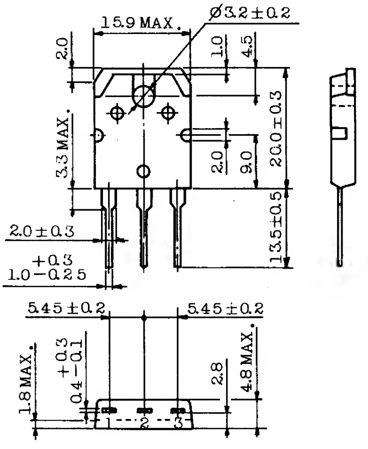
2SC3180

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1263
- Recommend for 40W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

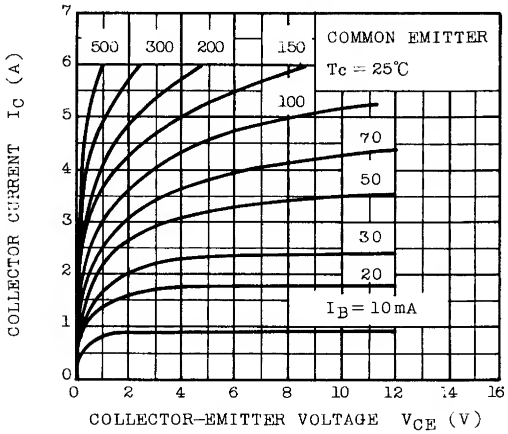
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	0.6	A
Collector Power Dissipation (Tc=25°C)	P_C	60	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

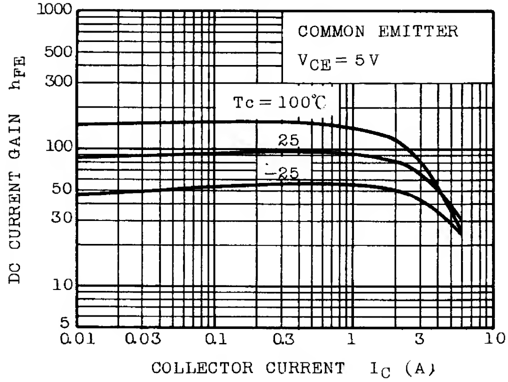
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=80V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=5V, I_C=3A	35	75	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	0.45	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=3A	-	0.92	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	105	-	pF

Note : $h_{FE(1)}$ Classification, R : 55～110 O : 80～160

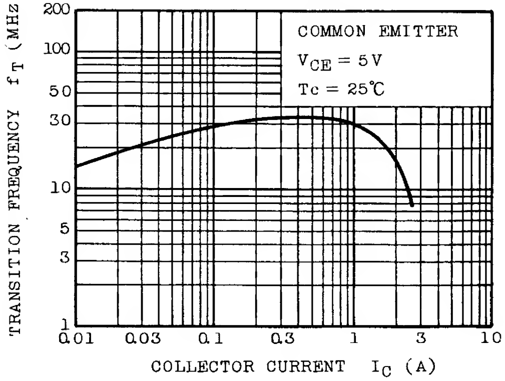
I_C − V_{CE}



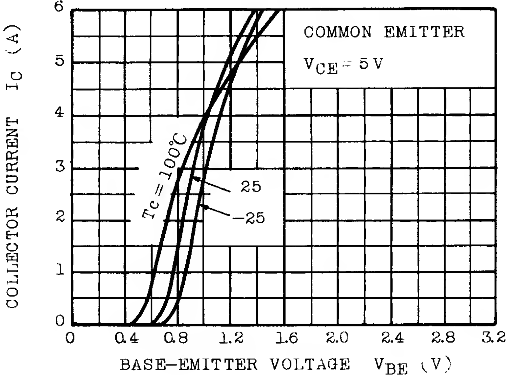
h_{FE} − I_C



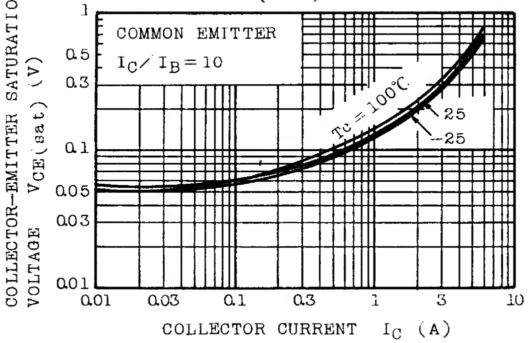
f_T − I_C



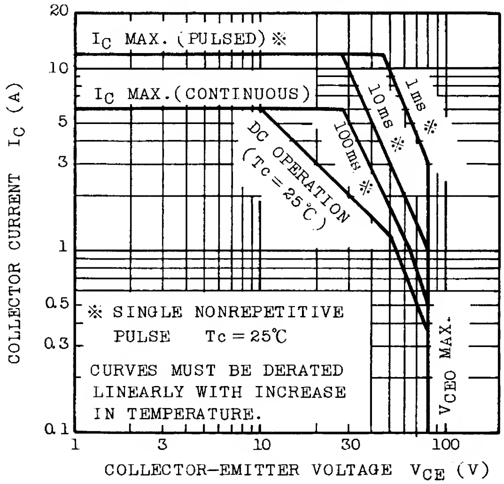
$V_{CE(sat)}$ − I_C



$V_{CE(sat)}$ − I_C



SAFE OPERATION AREA



SILICON NPN TRIPLE DIFFUSED TYPE

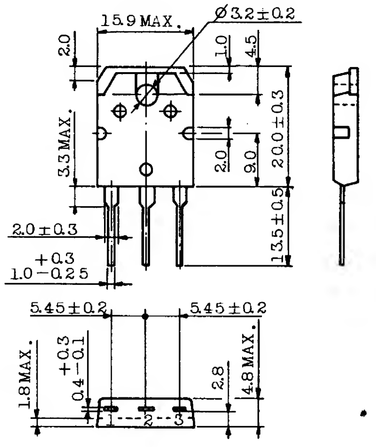
2SC3181

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1264
- Recommend for 55W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

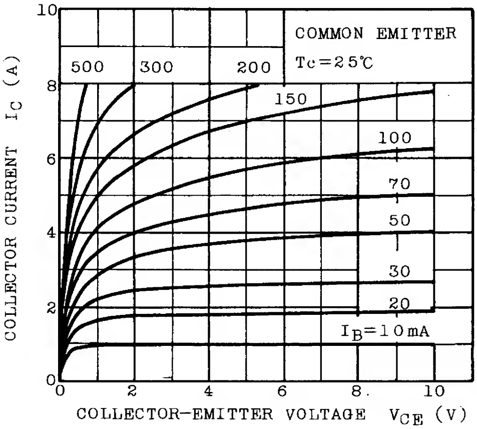
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	120	V
Collector-Emitter Voltage	V_{CEO}	120	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	8	A
Base Current	I_B	0.8	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

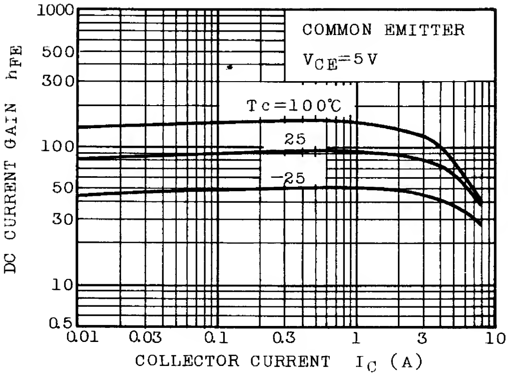
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=120V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=5V, I_C=4A	35	75	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=6A, I_B=0.6A	-	0.35	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=4A	-	0.95	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	190	-	pF

Note : $h_{FE(1)}$ Classification, R : 55~110 O : 80~160

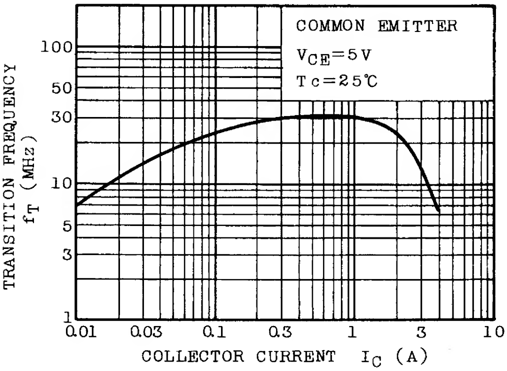
I_C – V_{CE}



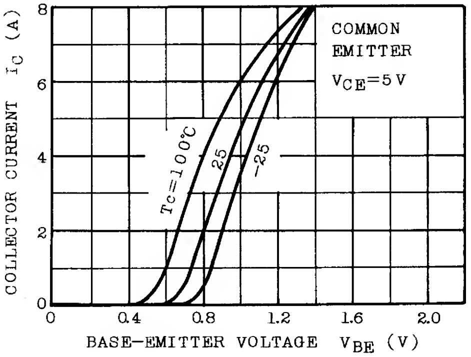
h_{FE} – I_C



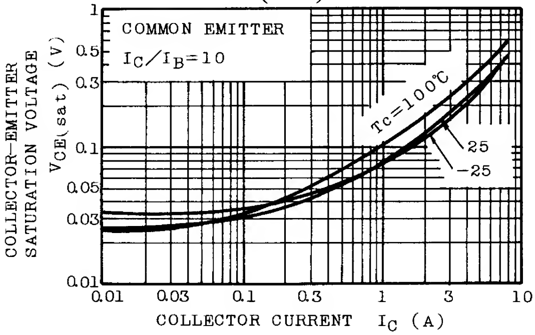
f_T – I_C



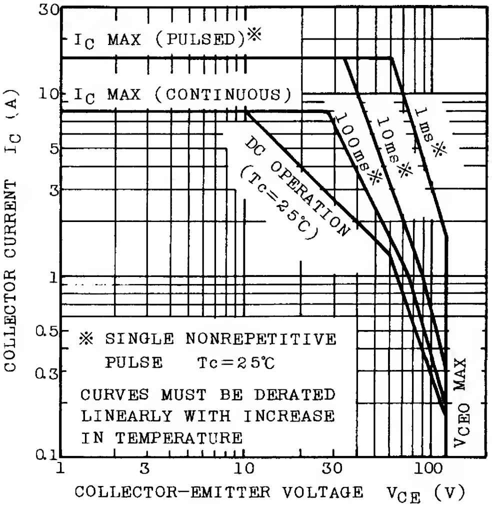
I_C – V_{BE}



$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

SILICON NPN TRIPLE DIFFUSED TYPE

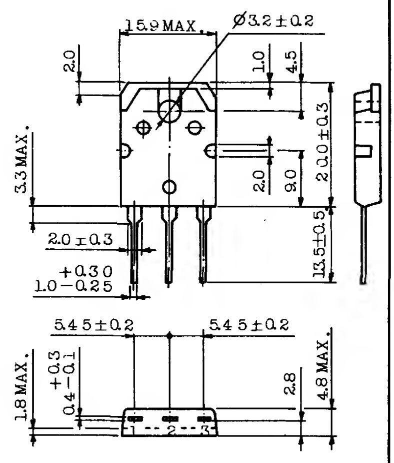
2SC3182

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1265
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-16B1A

Weight : 4.6g

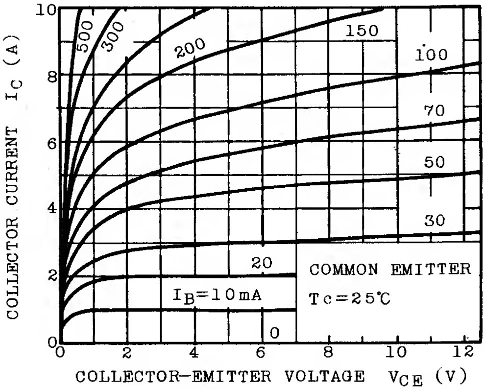
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	140	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

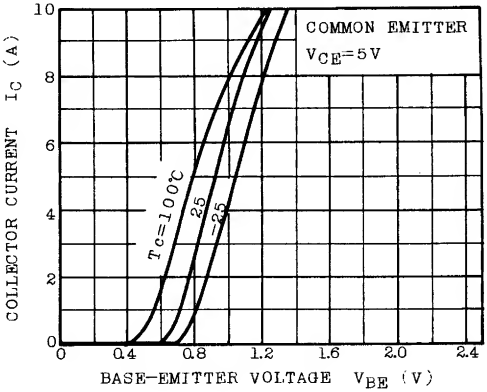
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=140V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=5V, I_C=5A	35	83	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=7A, I_B=0.7A	-	0.3	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	0.9	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	220	-	pF

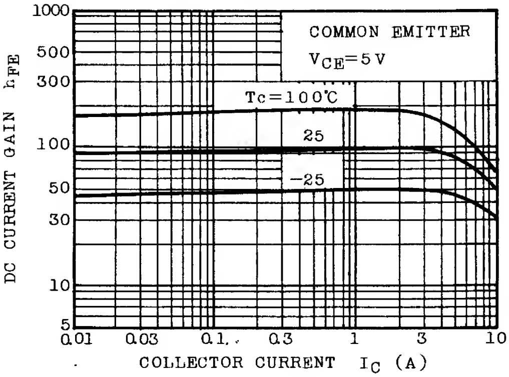
Note : $h_{FE(1)}$ Classification R : 55~110, O : 80~160



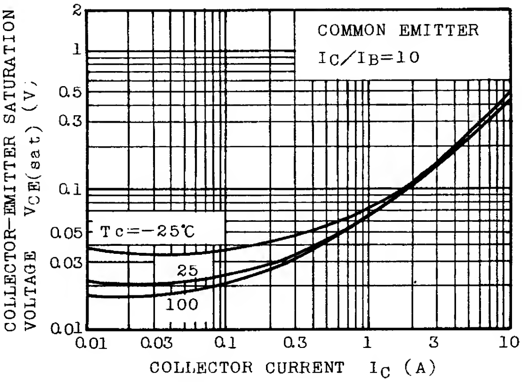
$I_C - V_{CE}$



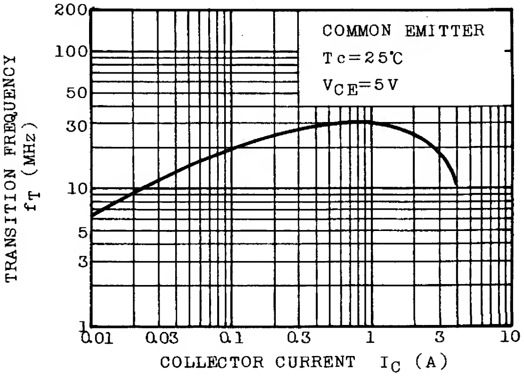
$I_C - V_{BE}$



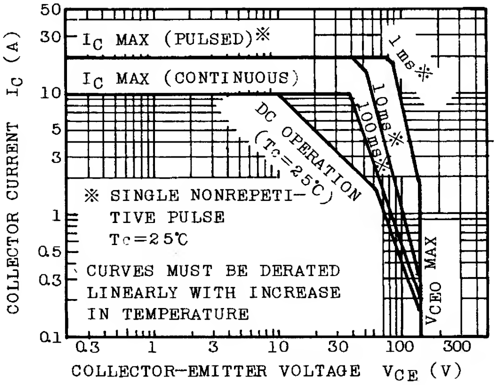
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$f_T - I_C$



SAFE OPERATING AREA

SILICON NPN TRIPLE DIFFUSED TYPE

2SC3233

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

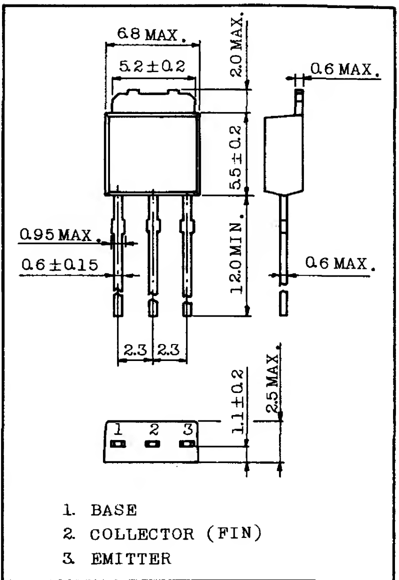
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES;

. Excellent Switching Times
    : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=0.8A

. High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

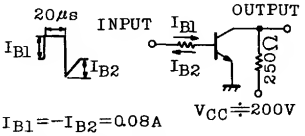
JEDEC	―
EIAJ	―
TOSHIBA	2-7B1A

Weight : 0.36g

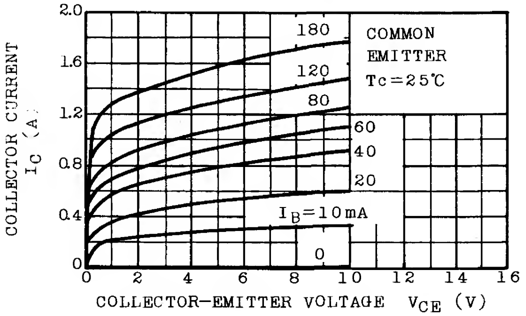
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

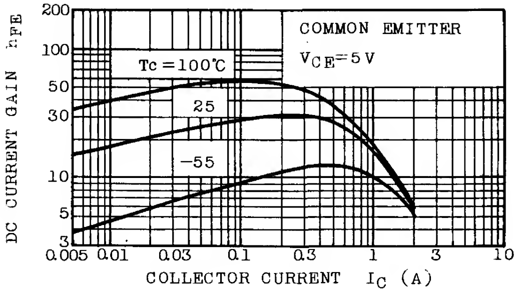
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	
			V_{CE}=5V, I_C=1A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs INPUT I_{B1} I_{B1} I_{B2} I_{B2} OUTPUT 250Ω V_{CC}≑200V I_{B1}=−I_{B2}=0.08A DUTY CYCLE<1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

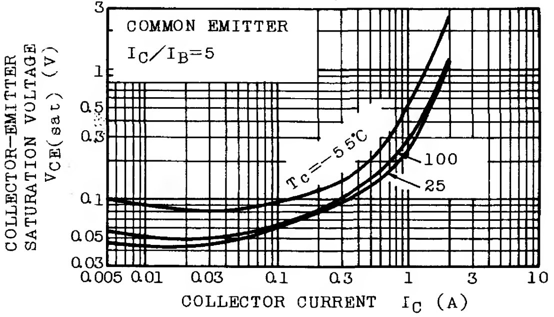
I_C – V_{CE}



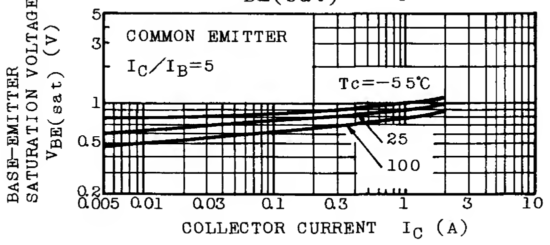
h_{FE} – I_C



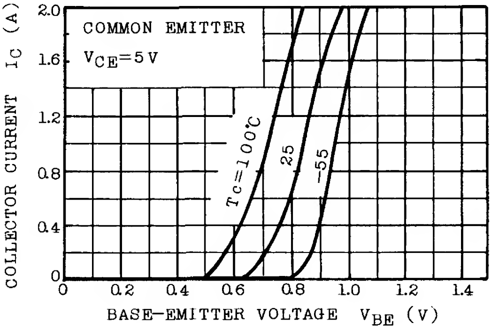
$V_{CE(sat)}$ – I_C



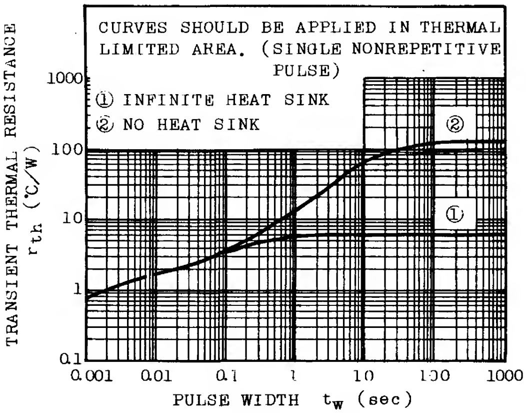
$V_{BE(sat)}$ – I_C



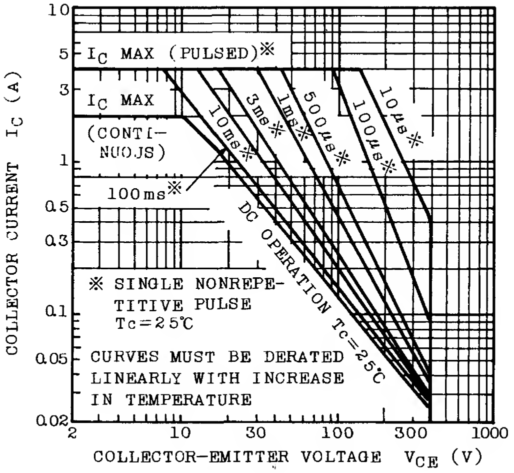
I_C – V_{BE}



r_{th} – t_w



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

2SC3235

INDUSTRIAL APPLICATIONS

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

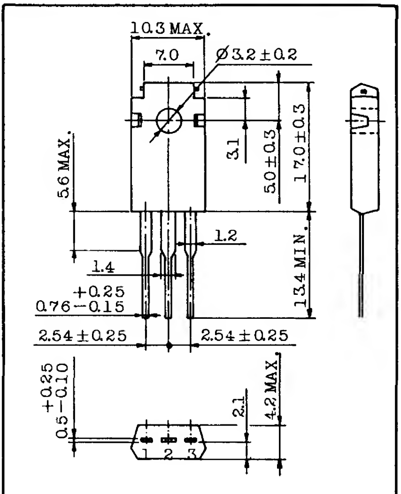
FEATURES:

. Excellent Switching Times

t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=0.8A

. High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

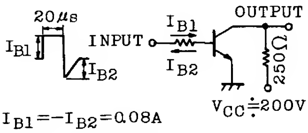
JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

Weight : 2.0g

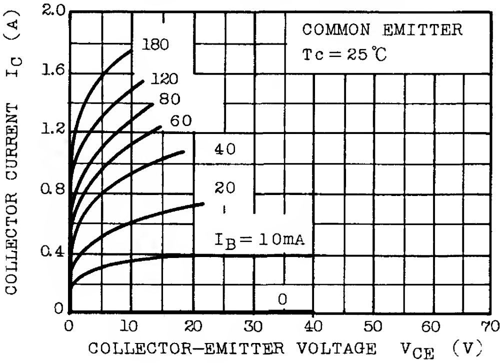
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.7	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

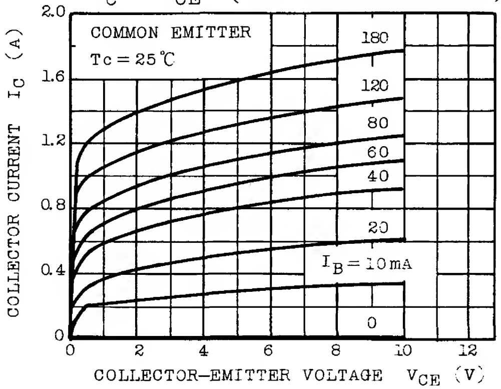
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	
			V_{CE}=5V, I_C=1A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs, I_{B1}, I_{B2}, INPUT, OUTPUT, 250Ω, V_{CC}≑200V I_{B1}=−I_{B2}=0.08A DUTY CYCLE<1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

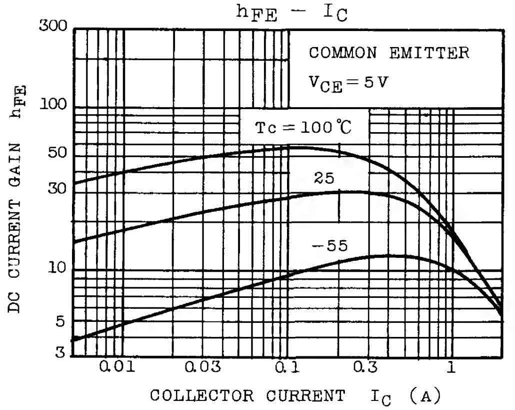
STATIC CHARACTERISTICS



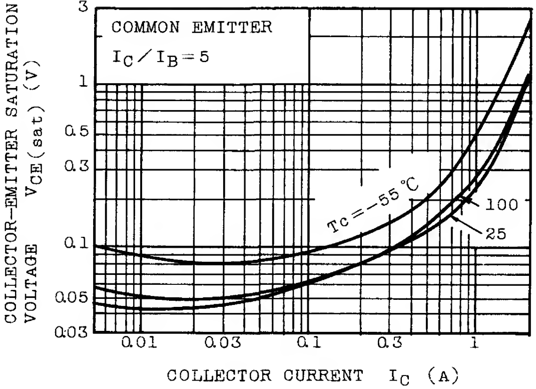
I_C – V_{CE} (LOW VOLTAGE REGION)



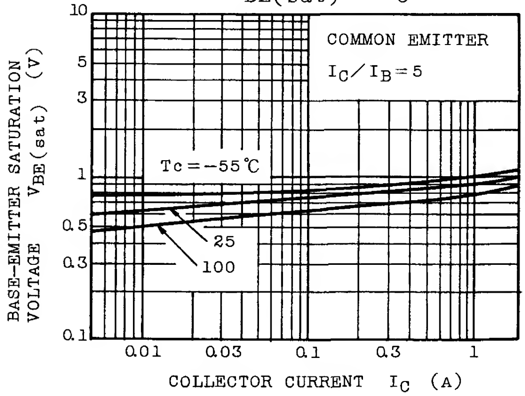
h_{FE} – I_C



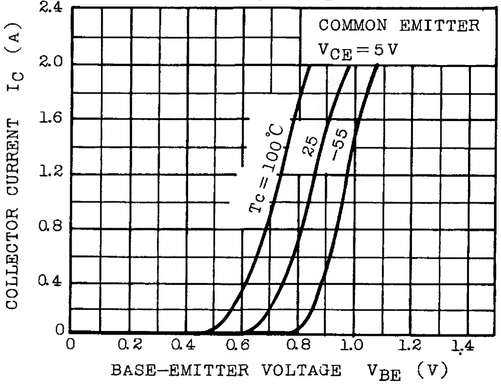
$V_{CE(sat)}$ – I_C

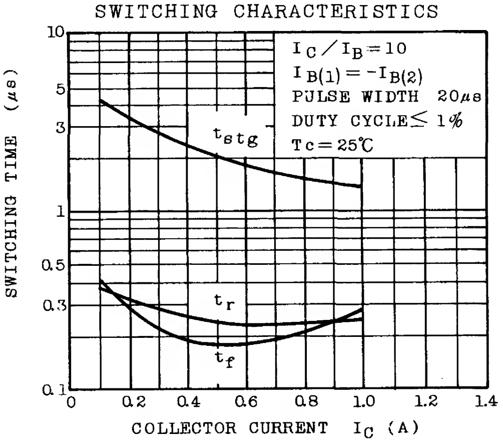


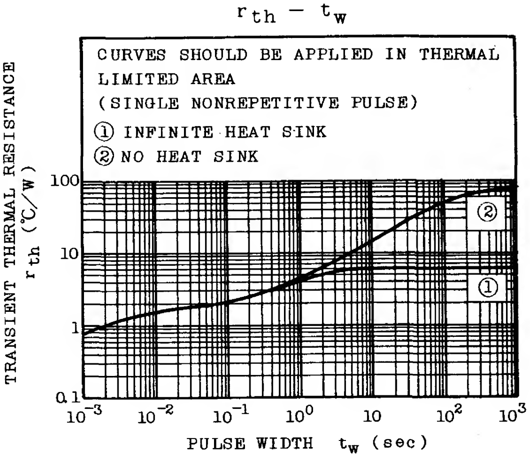
$V_{BE(sat)}$ – I_C

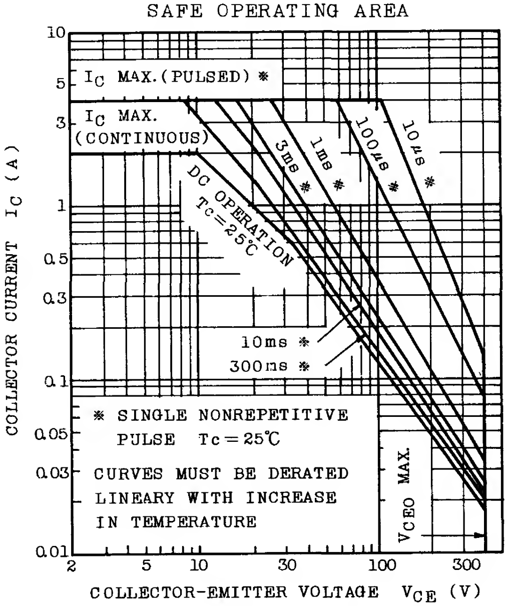


I_C – V_{BE}




SWITCHING CHARACTERISTICS
$I_C/I_B=10$
$I_{B(1)}=-I_{B(2)}$
PULSE WIDTH 20μs
DUTY CYCLE≦ 1%
Tc=25℃
t_{stg}
t_r
t_f
SWITCHING TIME (μs)
10
5
3
1
0.5
0.3
0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
COLLECTOR CURRENT I_C (A)


$r_{th}-t_w$
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA
(SINGLE NONREPETITIVE PULSE)
① INFINITE HEAT SINK
② NO HEAT SINK
②
①
TRANSIENT THERMAL RESISTANCE r_{th} (℃/W)
100
10
1
0.1
10^{-3}
10^{-2}
10^{-1}
10^{0}
10
10^{2}
10^{3}
PULSE WIDTH t_w (sec)


SAFE OPERATING AREA
I_C MAX.(PULSED) ※
I_C MAX. (CONTINUOUS)
10μs ※
100μs ※
1ms ※
3ms ※
DC OPERATION Tc=25℃
10ms ※
300ms ※
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
2
5
10
30
100
300
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

2SC3236

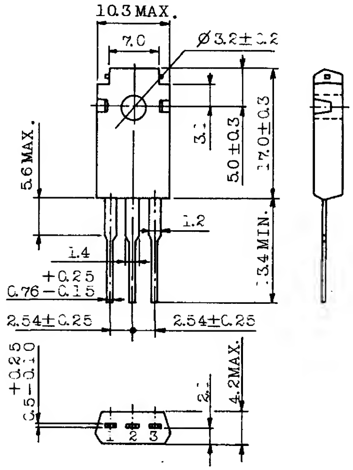
SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-10K1A

Weight : 2.0g

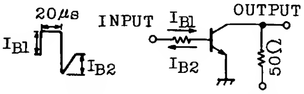
FEATURES:

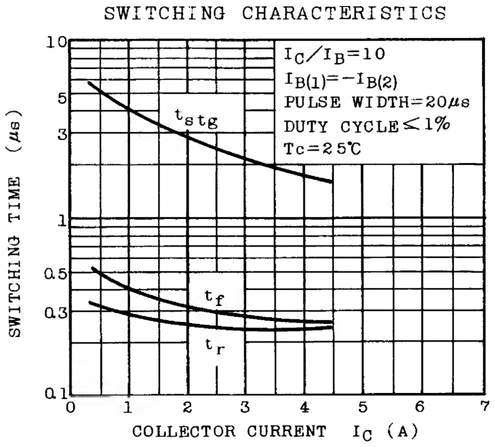
- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=4A
- High Collector Breakdown Voltage : V_{CEO}=400V

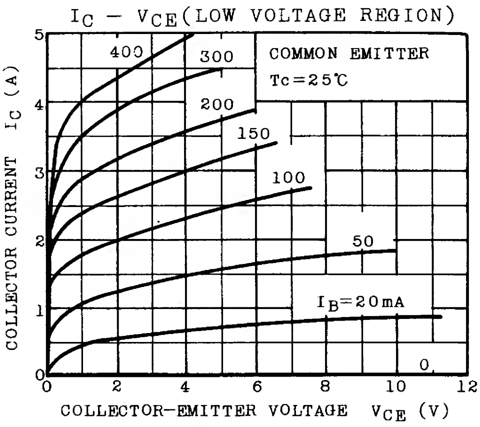
MAXIMUM RATINGS (Ta=25°C)

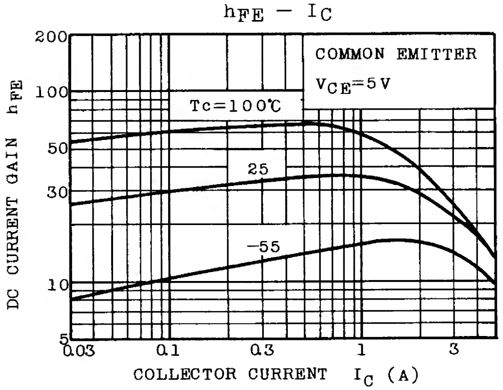
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	7	
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.7	W
	Tc=25°C		60	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

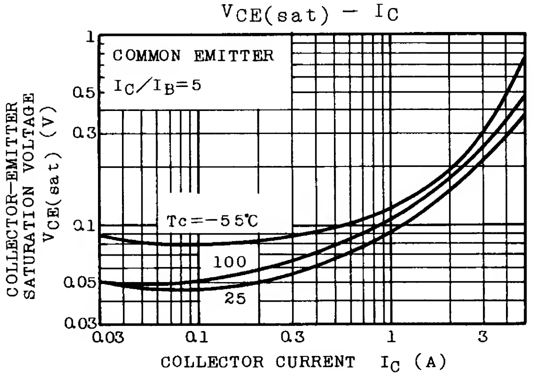
ELECTRICAL CHARACTERISTICS (Ta=25°C)

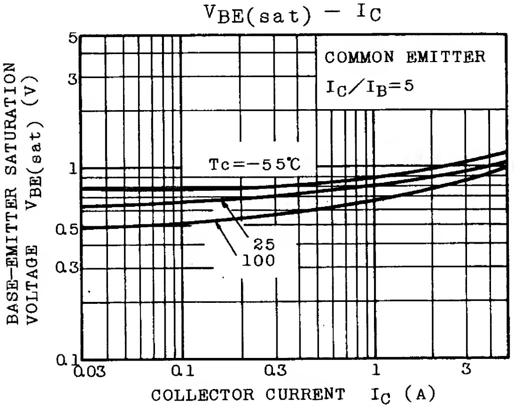
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=3A	12	-	-	
			V_{CE}=5V, I_C=5A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Switching Time	Rise Time	t_r	 I_{B1}=−I_{B2}=0.4A V_{CC}≑200V DUTY CYCLE<1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

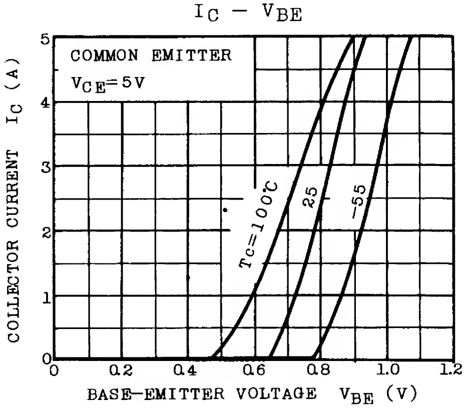

SWITCHING CHARACTERISTICS
$I_C/I_B=10$
$I_{B(1)}=-I_{B(2)}$
PULSE WIDTH=20μs
DUTY CYCLE≤1%
Tc=25℃
t_{stg}
t_f
t_r
SWITCHING TIME (μs)
10
5
3
1
0.5
0.3
0.1
0
1
2
3
4
5
6
7
COLLECTOR CURRENT I_C (A)

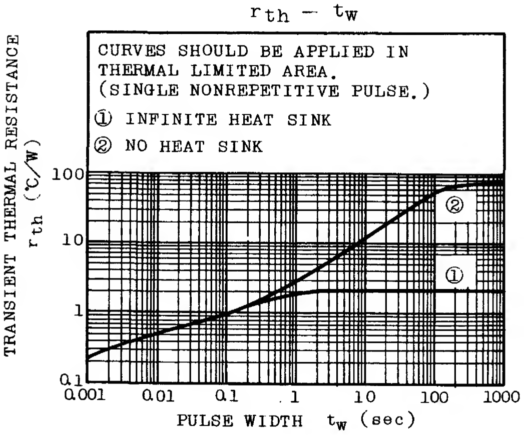

I_C − V_{CE}(LOW VOLTAGE REGION)
COMMON EMITTER
Tc=25℃
400
300
200
150
100
50
I_B=20mA
0
COLLECTOR CURRENT I_C (A)
5
4
3
2
1
0
0
2
4
6
8
10
12
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


h_{FE} − I_C
COMMON EMITTER
V_{CE}=5V
Tc=100℃
25
−55
DC CURRENT GAIN h_{FE}
200
100
50
30
10
5
0.03
0.1
0.3
1
3
COLLECTOR CURRENT I_C (A)

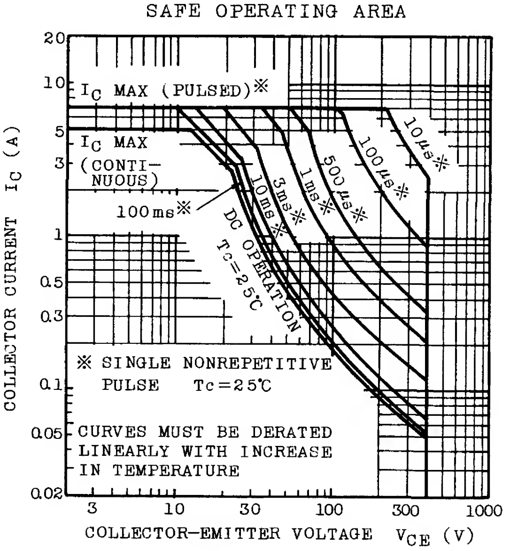

$V_{CE(sat)}$ − I_C
COMMON EMITTER
I_C/I_B=5
Tc=−55℃
100
25
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
1
0.5
0.3
0.1
0.05
0.03
0.03
0.1
0.3
1
3
COLLECTOR CURRENT I_C (A)


$V_{BE(sat)}$ − I_C
COMMON EMITTER
I_C/I_B=5
Tc=−55℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
5
3
1
0.5
0.3
0.1
0.03
0.1
0.3
1
3
COLLECTOR CURRENT I_C (A)


I_C − V_{BE}
COMMON EMITTER
V_{CE}=5V
Tc=100℃
25
−55
COLLECTOR CURRENT I_C (A)
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
1.0
1.2
BASE-EMITTER VOLTAGE V_{BE} (V)



$r_{th} - t_w$



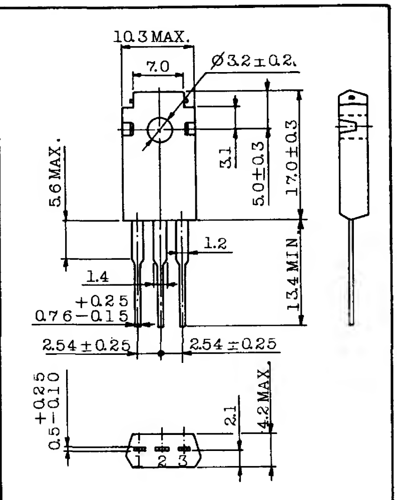
SAFE OPERATING AREA

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3239

HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−10K1A

Weight : 2.0g

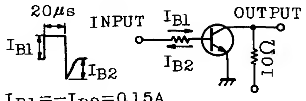
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) (at I_C=3A)
- High Speed Switching Time : t_{stg}=1.0μs(Typ.)
- Complementary to 2SA1279

MAXIMUM RATINGS (Ta=25°C)

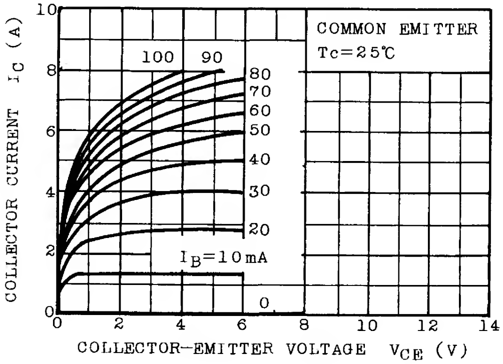
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

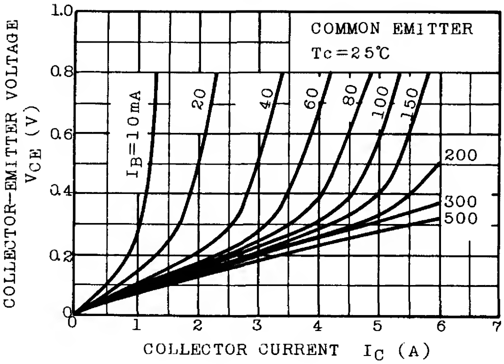
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=3A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=0.15A	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=3A, I_B=0.15A	-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	120	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	80	-	MHz
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} OUTPUT I_{B1} I_{B2} I_{B2} 10Ω I_{B1}=$-I_{B2}$=0.15A DUTY CYCLE≦1% V_{CC}=30V	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

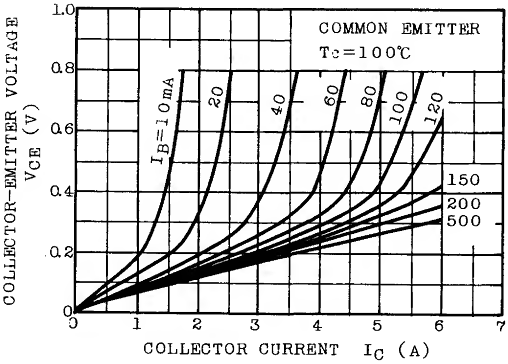
$I_C - V_{CE}$



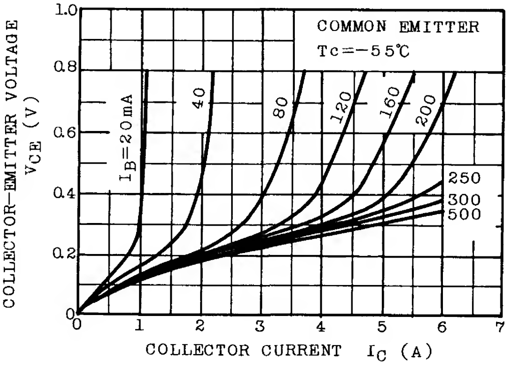
$V_{CE} - I_C$



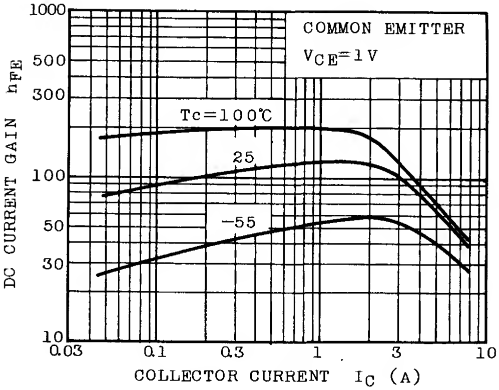
$V_{CE} - I_C$



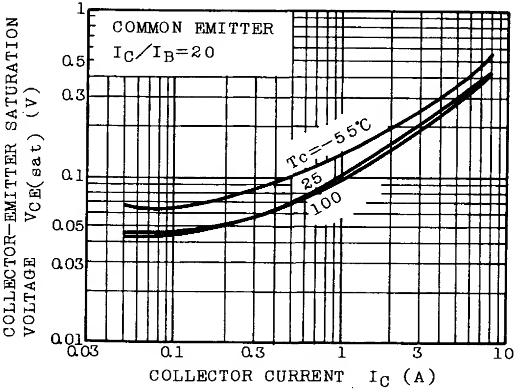
$V_{CE} - I_C$

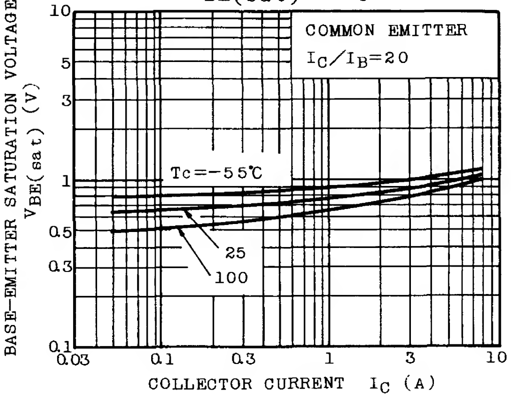


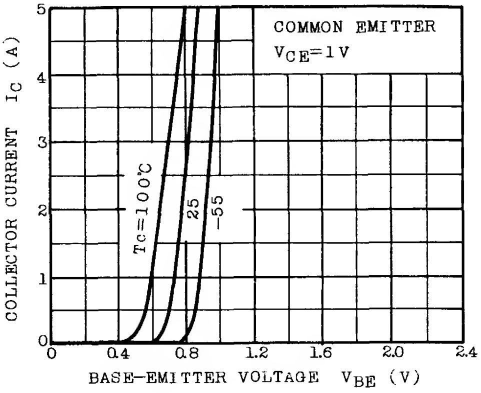
$h_{FE} - I_C$

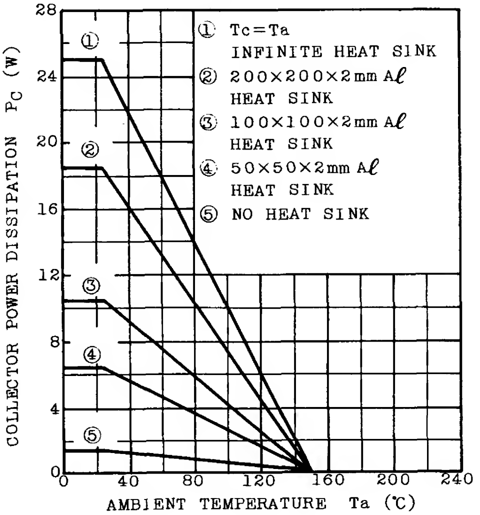


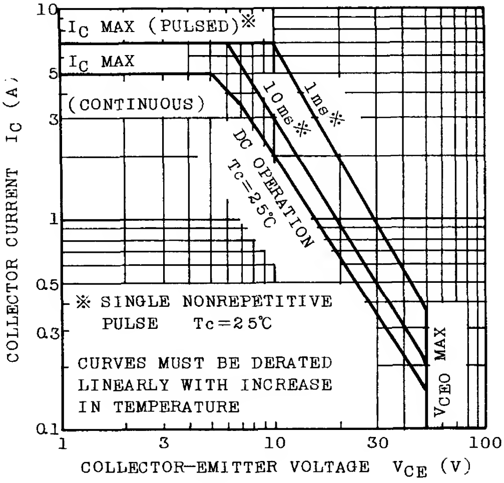
$V_{CE(sat)} - I_C$




$V_{BE(sat)} - I_C$


$I_C - V_{BE}$


P_C − Ta


SAFE OPERATING AREA

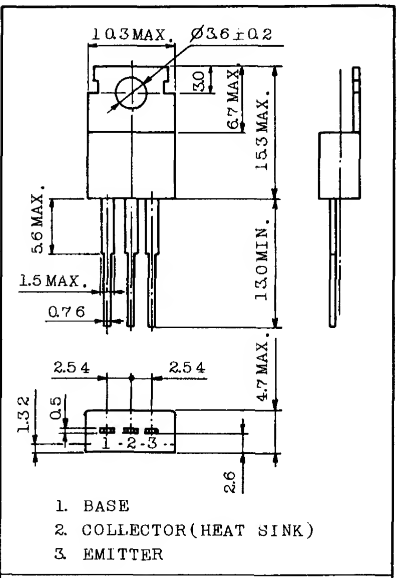
2SC3257

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

INDUSTRIAL APPLICATIONS
Unit in mm



JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75
Weight : 1.9g

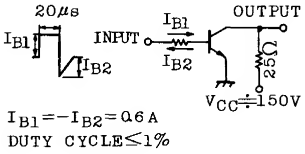
FEATURES:

- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=6A
- High Collector Breakdown Voltage : V_{CEO}=200V

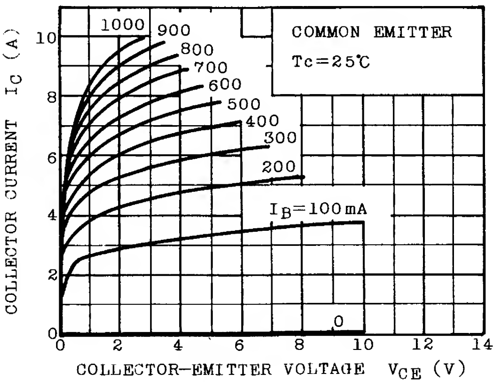
MAXIMUM RATINGS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	250	V
Collector-Emitter Voltage		V_{CEO}	200	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	
Base Current		I_B	2	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.5	W
	$Tc=25^{\circ}C$		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

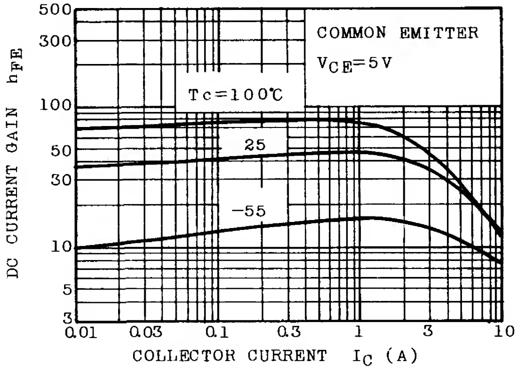
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=200V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	250	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	200	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=10mA	15	-	-	
			V_{CE}=5V, I_C=5A	20	-	80	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 25Ω V_{CC}≑150V I_{B1}=−I_{B2}=0.6A DUTY CYCLE≤1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

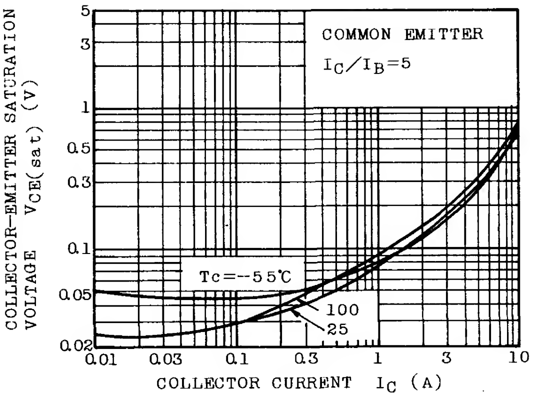
I_C — V_{CE}



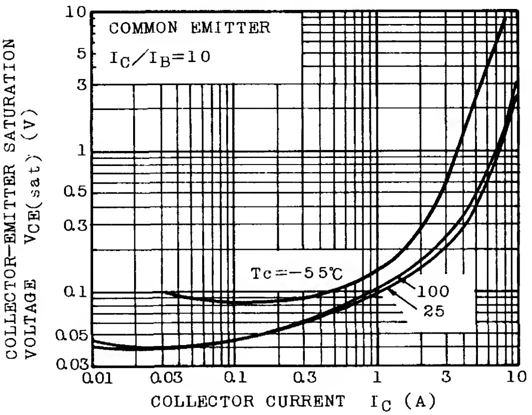
h_{FE} — I_C



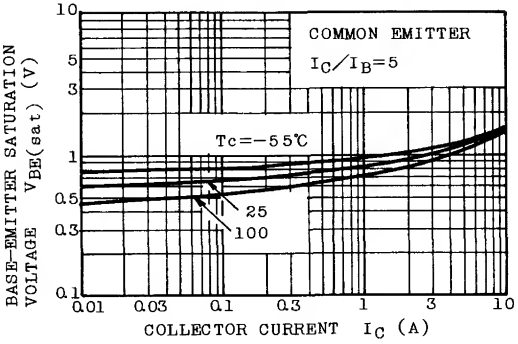
$V_{CE(sat)}$ — I_C



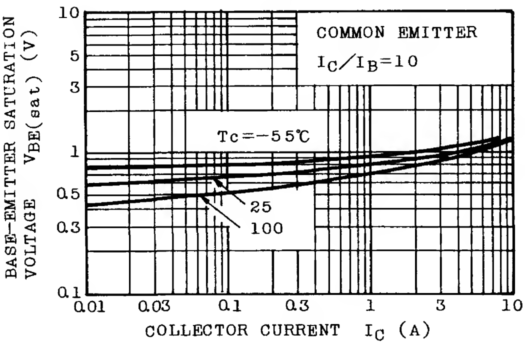
$V_{CE(sat)}$ — I_C



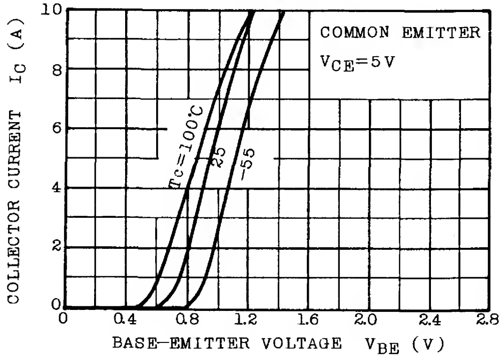
$V_{BE(sat)}$ — I_C



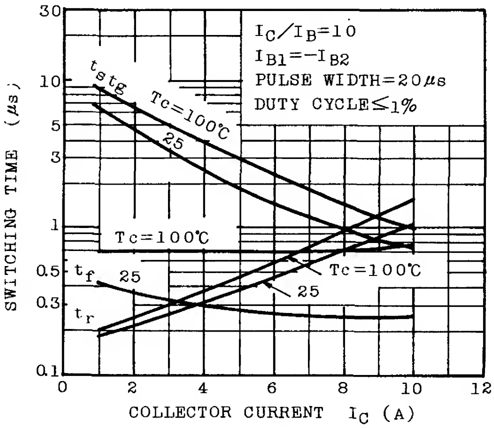
$V_{BE(sat)}$ — I_C



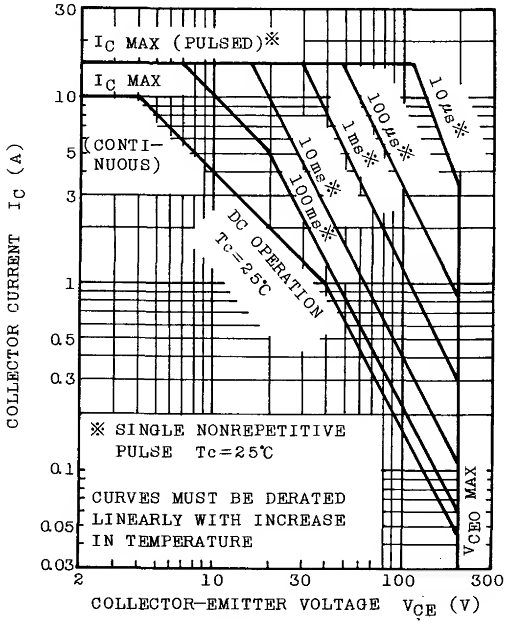
$I_C - V_{BE}$



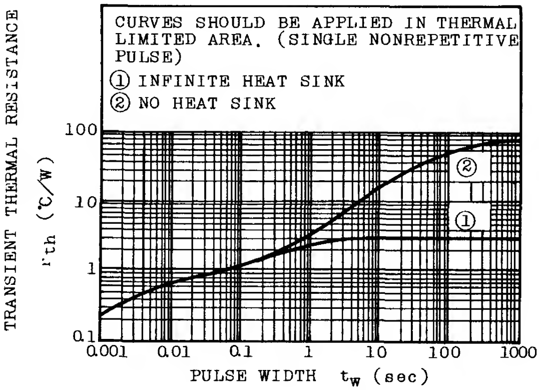
SWITCHING CHARACTERISTICS



SAFE OPERATING AREA



$r_{th} - t_w$

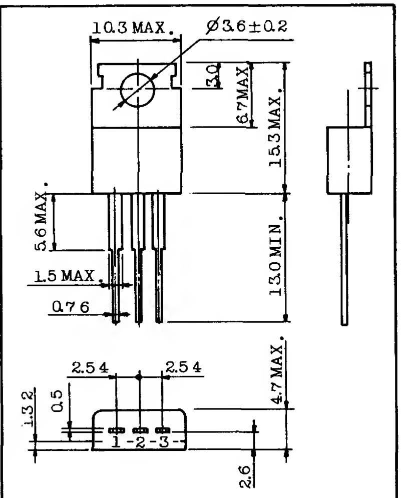


SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3258

HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75
Weight : 1.9g

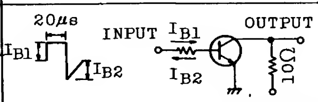
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) at I_C=3A
- High Speed Switching Time : t_{stg}=1.0μs(Typ.)
- Complementary to 2SA1293.

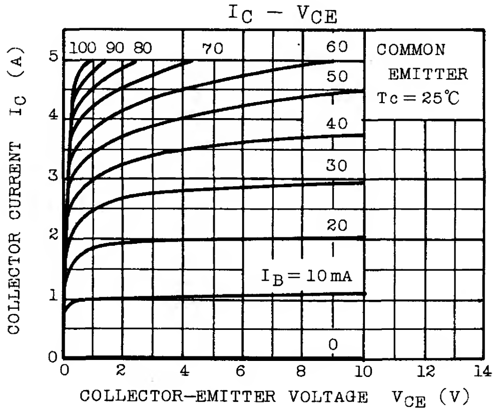
MAXIMUM RATINGS (Ta=25°C)

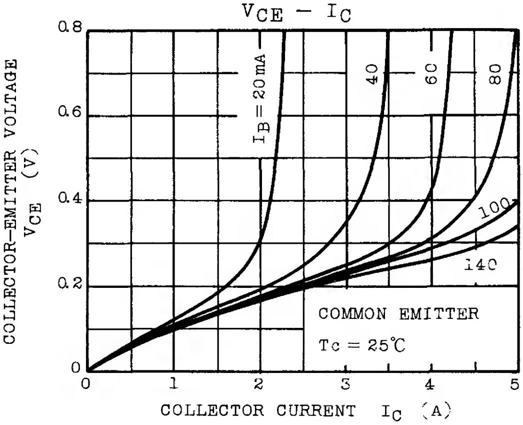
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	8	
Collector Power Dissipation (Tc=25°C)		P_C	30	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

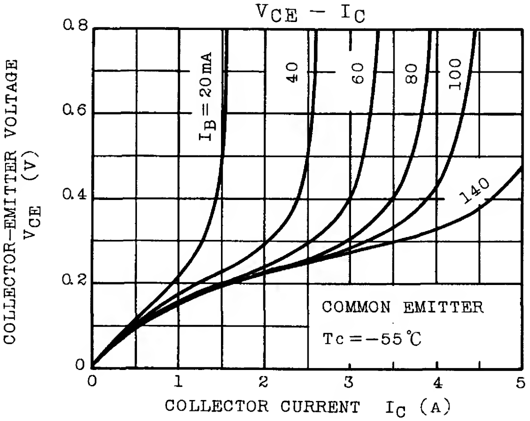
ELECTRICAL CHARACTERISTICS (Ta=25°C)

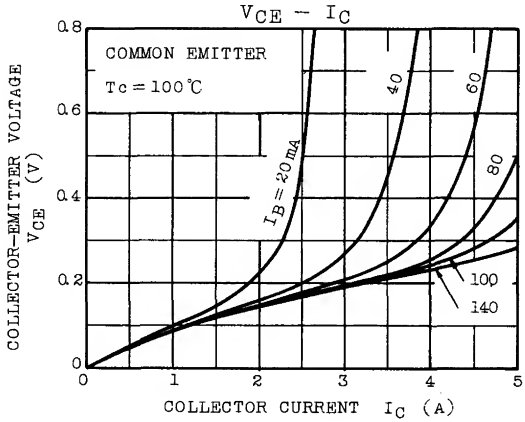
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=3A	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=0.15A	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$		-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	120	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=−I_{B2}=0.15A V_{CC}≑30V DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

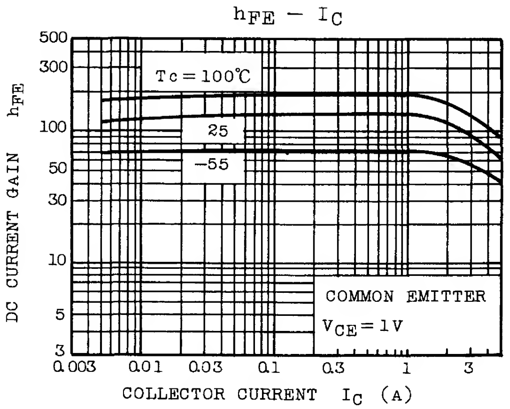
Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

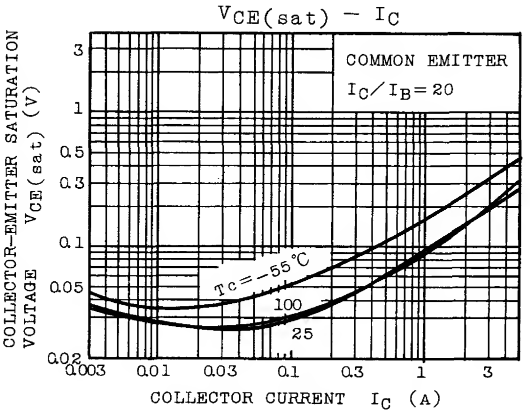

I_C – V_{CE}
COMMON EMITTER
Tc = 25℃
I_B = 10 mA
100 90 80 70 60 50 40 30 20 0
COLLECTOR CURRENT I_C (A)
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
0 1 2 3 4 5
0 2 4 6 8 10 12 14


V_{CE} – I_C
I_B = 20 mA
40 60 80 100 140
COMMON EMITTER
Tc = 25℃
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)
0 0.2 0.4 0.6 0.8
0 1 2 3 4 5

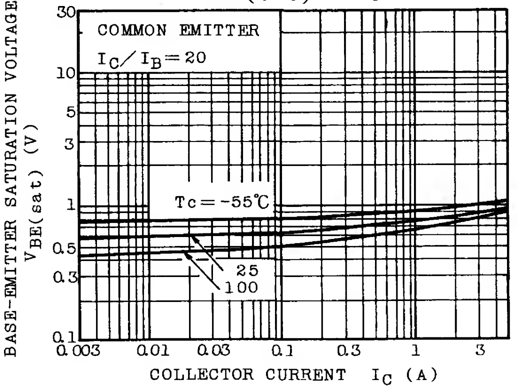

V_{CE} – I_C
I_B = 20 mA
40 60 80 100 140
COMMON EMITTER
Tc = −55℃
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)
0 0.2 0.4 0.6 0.8
0 1 2 3 4 5


V_{CE} – I_C
COMMON EMITTER
Tc = 100℃
I_B = 20 mA
40 60 80 100 140
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)
0 0.2 0.4 0.6 0.8
0 1 2 3 4 5

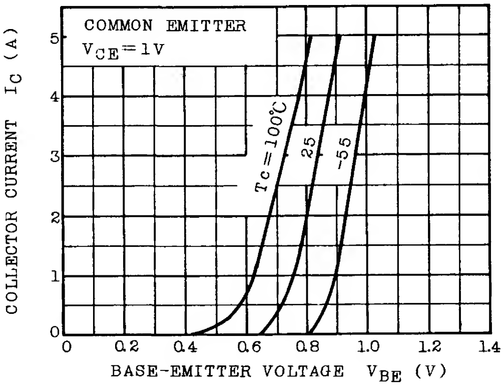

h_{FE} – I_C
Tc = 100℃
25
−55
COMMON EMITTER
V_{CE} = 1 V
DC CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C (A)
3 5 10 30 50 100 300 500
0.003 0.01 0.03 0.1 0.3 1 3


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B = 20
Tc = −55℃
100
25
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
COLLECTOR CURRENT I_C (A)
0.02 0.05 0.1 0.3 0.5 1 3
0.003 0.01 0.03 0.1 0.3 1 3

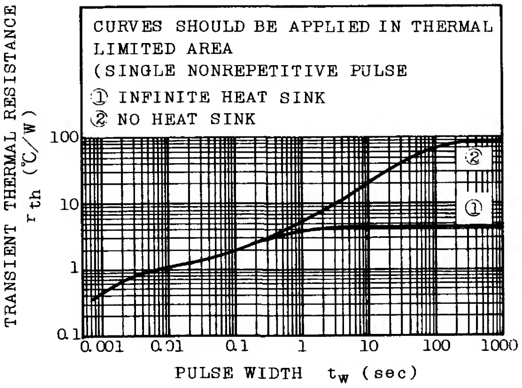
$V_{BE(sat)}$ – I_C



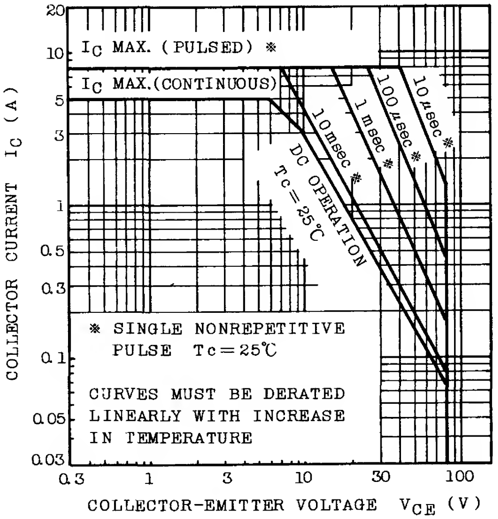
I_C – V_{BE}



r_{th} – t_w



SAFE OPERATING AREA



2SC3280

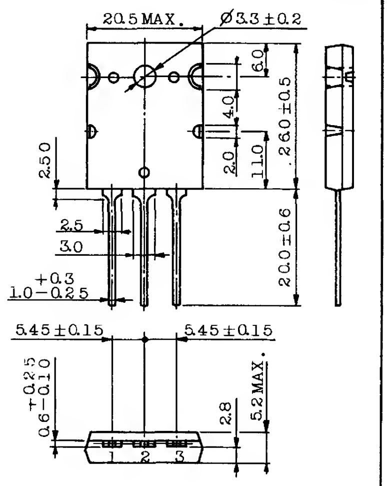
SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

Unit in mm

FEATURES:

- Complementary to 2SA1301
- Recommend for 80W High Fidelity Audio Frequency Amplifier Output Stage.



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−21F1A

Weight : 9.75g

MAXIMUM RATINGS (Ta=25°C)

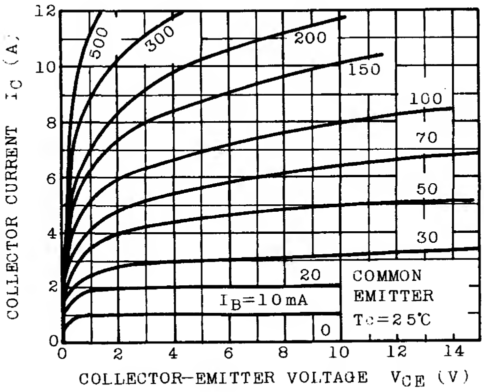
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	160	V
Collector-Emitter Voltage	V_{CEO}	160	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	12	A
Base Current	I_B	1.2	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

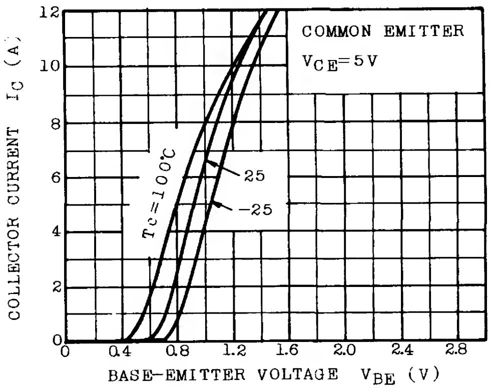
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=160V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	160	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=5V, I_C=6A	35	74	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=8A, I_B=0.8A	-	0.35	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=6A	-	1.0	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	220	-	pF

Note : $h_{FE(1)}$ Classification R : 55～110, O : 80～160

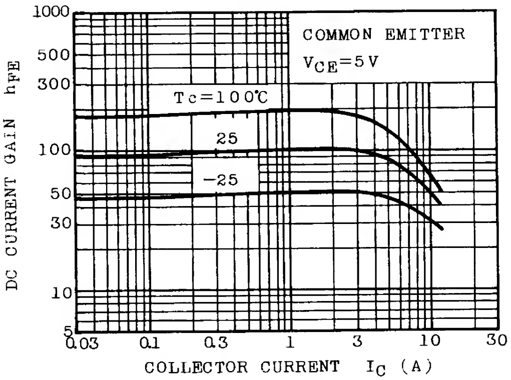
I_C – V_{CE}



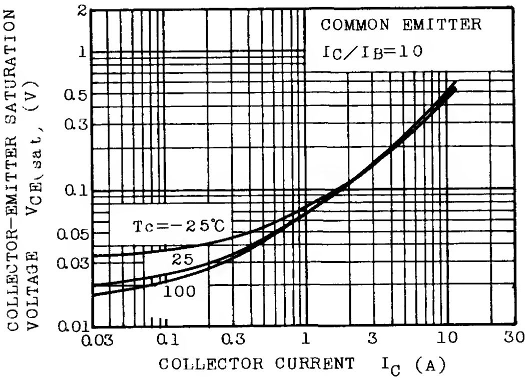
I_C – V_{BE}



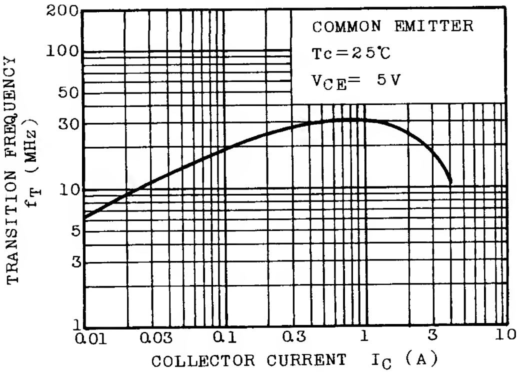
h_{FE} – I_C



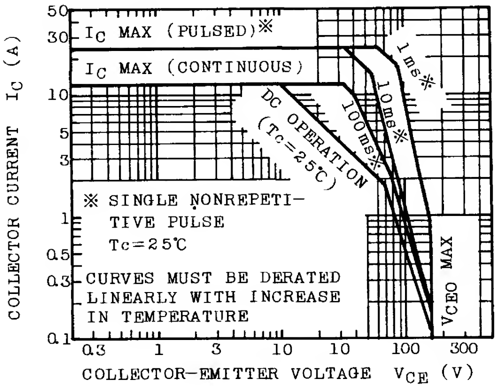
$V_{CE(sat)}$ – I_C



f_T – I_C



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

2SC3281

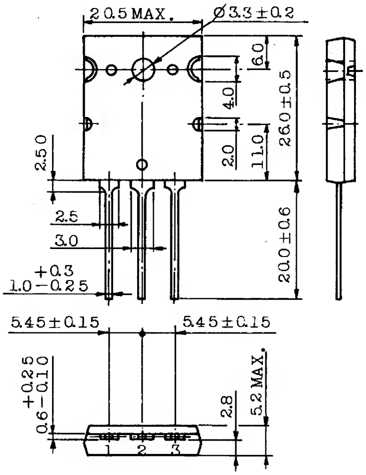
SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1302
- Recommend for 100W High Fiderity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−21F1A

Weight : 9.75g

MAXIMUM RATINGS (Ta=25°C)

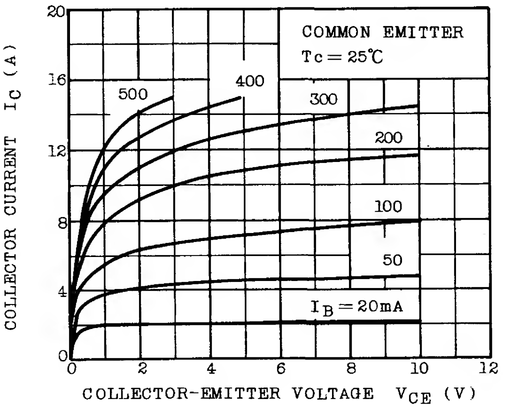
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	V_{CEO}	200	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	1.5	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

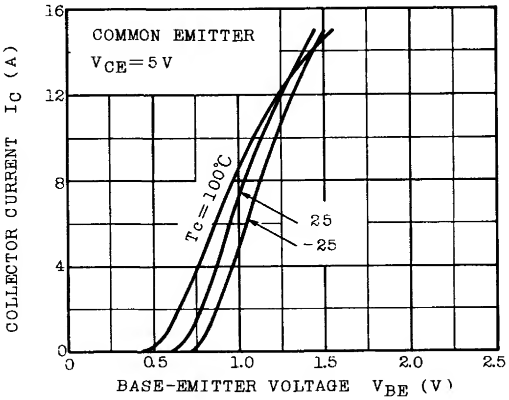
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	200	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	-
	$h_{FE(2)}$	V_{CE}=5V, I_C=8A	35	60	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10A, I_B=1A	-	0.40	3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=8A	-	1.0	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	30	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 55～110, O : 80～160

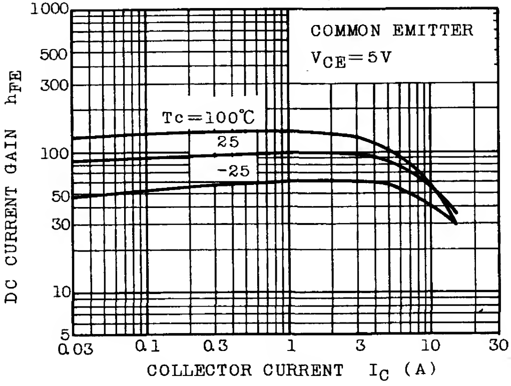
$I_C - V_{CE}$



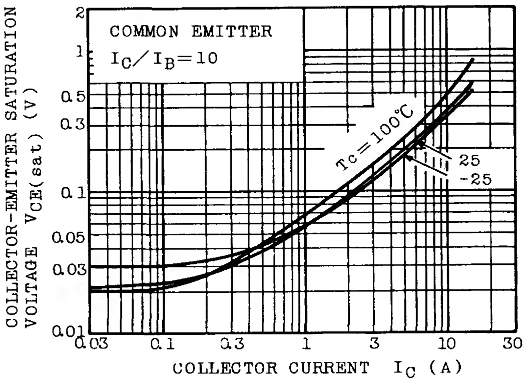
$I_C - V_{BE}$



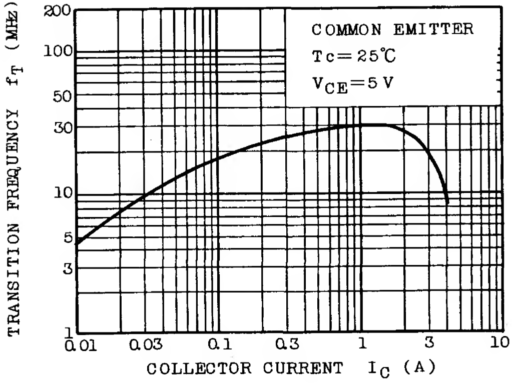
$h_{FE} - I_C$



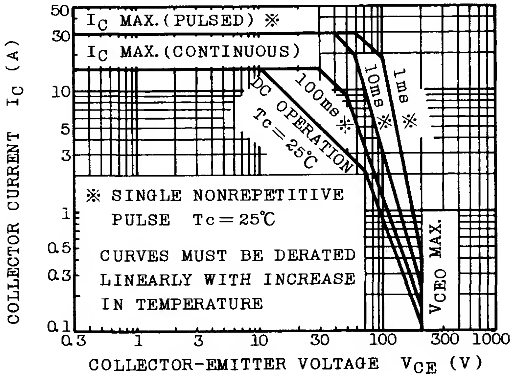
$V_{CE(sat)} - I_C$



$f_T - I_C$



SAFE OPERATING AREA



2SC3297

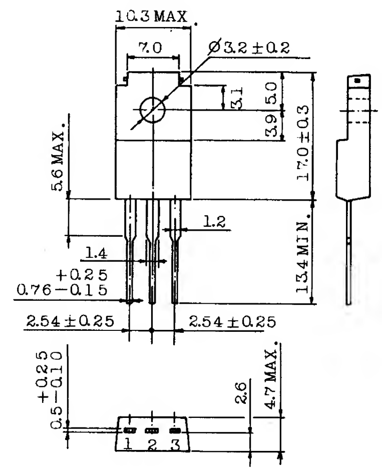
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of f_{FE}
- Complementary to 2SA1305 and 5W Output Applications.

Unit in mm



1. BASE
2. COLECTOR
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

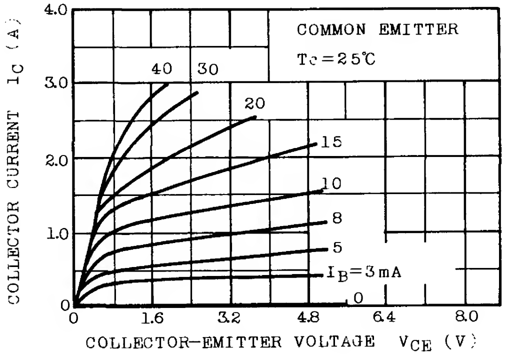
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Base Current	I_B	0.3	A
Collector Power Dissipation (Tc=25°C)	P_C	15	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

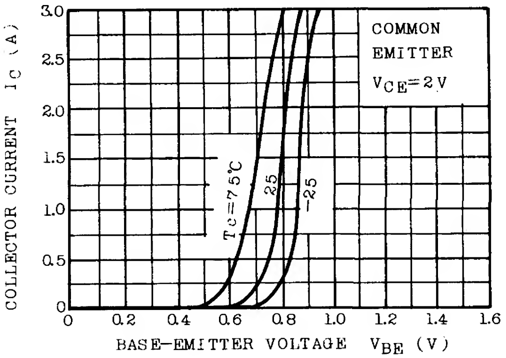
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=20V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	30	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=2V, I_C=0.5A	70	-	240	
	$h_{FE(2)}$	V_{CE}=2V, I_C=2.5A	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.2A	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=0.5A	-	0.75	1.0	V
Transition Frequency	f_T	V_{CE}=2V, I_C=0.5A	-	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	35	-	pF

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

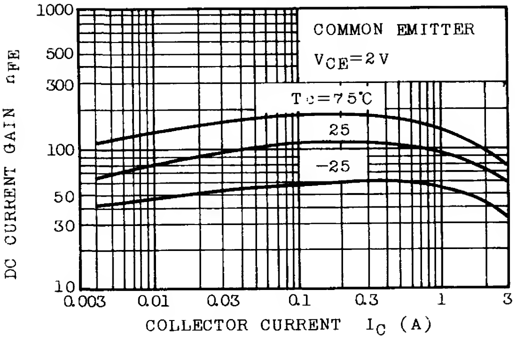
I_C – V_{CE}



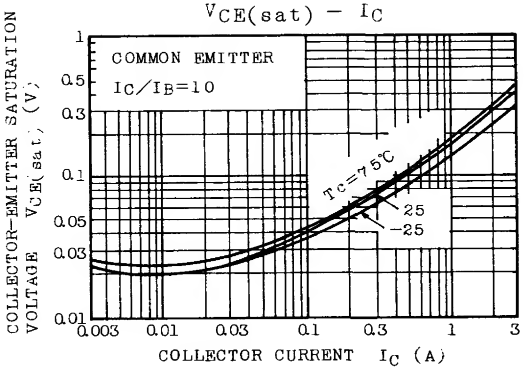
I_C – V_{BE}



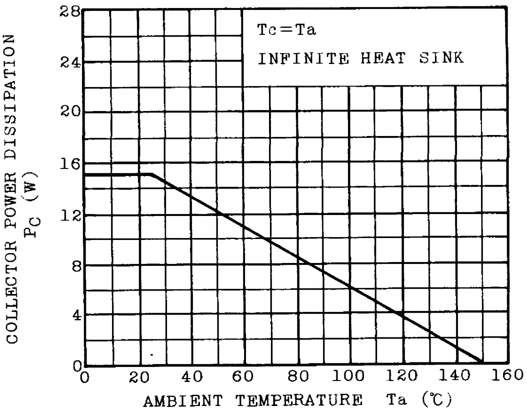
h_{FE} – I_C



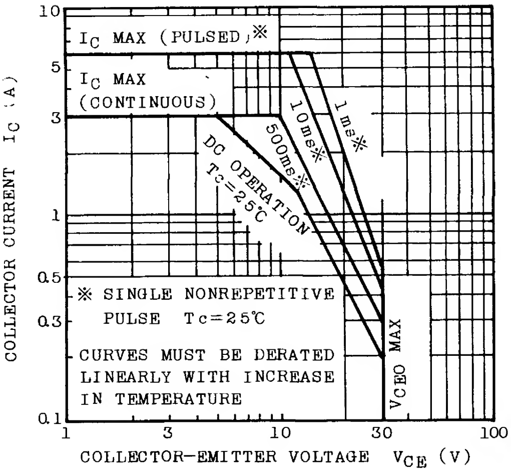
$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

2SC3298
2SC3298A
2SC3298B

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

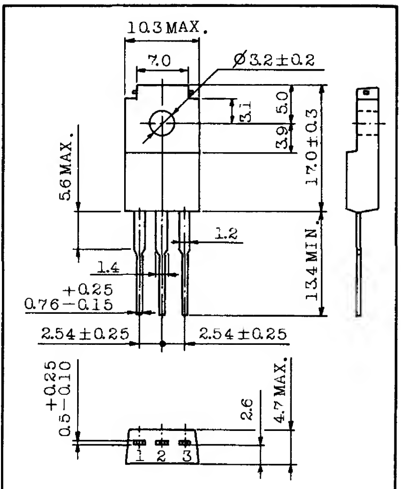
POWER AMPLIFIER APPLICATIONS.

DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : f_T=100MHz (Typ.)
- Complementary to 2SA1306, 2SA1306A, 2SA1306B

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS

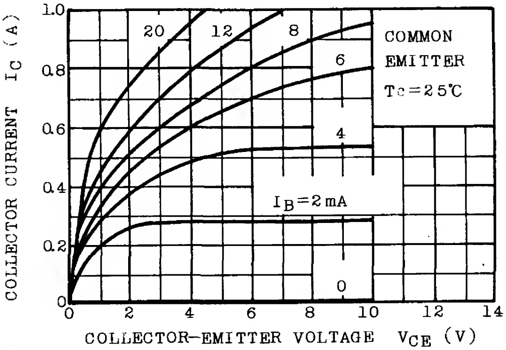
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC3298	V_{CBO}	160	V
	2SC3298A		180	
	2SC3298B		200	
Collector-Emitter Voltage	2SC3298	V_{CEO}	160	V
	2SC3298A		180	
	2SC3298B		200	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.15	A
Collector Power Dissipation (Tc=25°C)		P_C	20	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

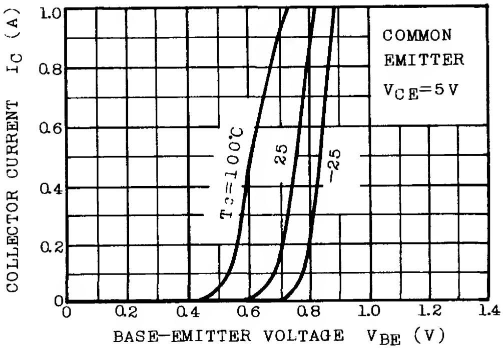
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=160V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	2SC3298	$V_{(BR)CEO}$	I_C=10mA, I_B=0	160	-	-	V
	2SC3298A			180	-	-	
	2SC3298B			200	-	-	
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=100mA	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=100mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_C=0, f=1MHz	-	25	-	pF

Note : h_{FE} Classification O : 70～140, Y : 120～240

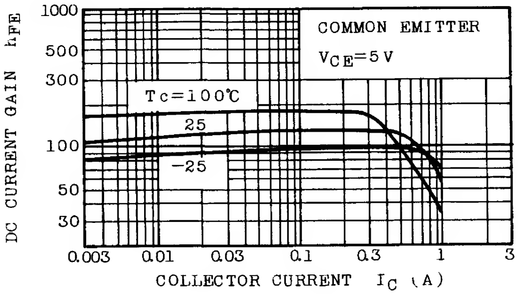
I_C − V_{CE}



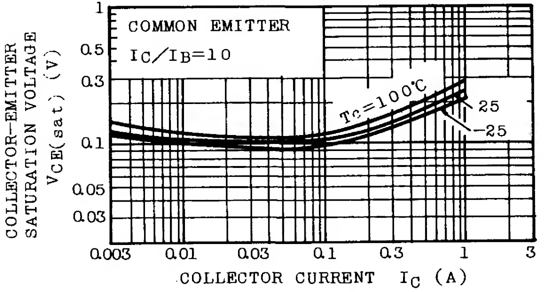
I_C − V_{BE}



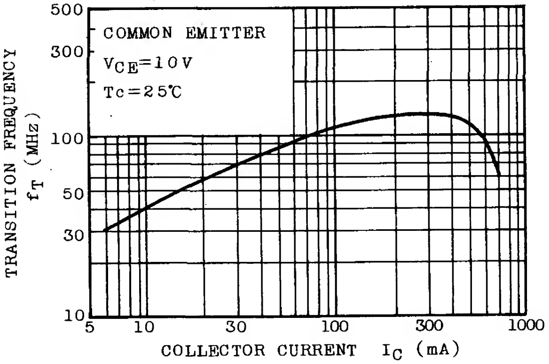
h_{FE} − I_C



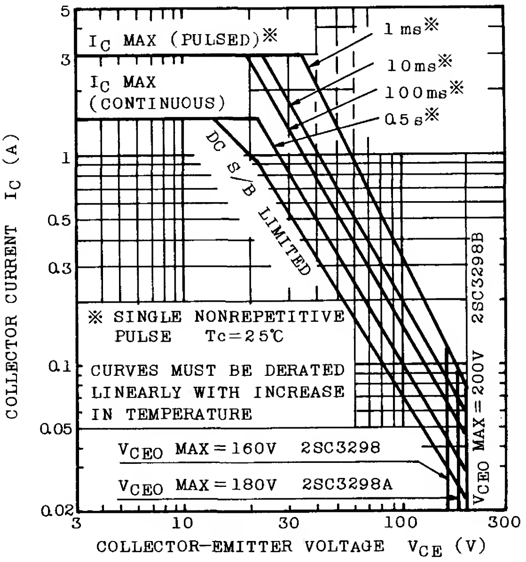
$V_{CE(sat)}$ − I_C



f_T − I_C



SAFE OPERATING AREA



2SC3299

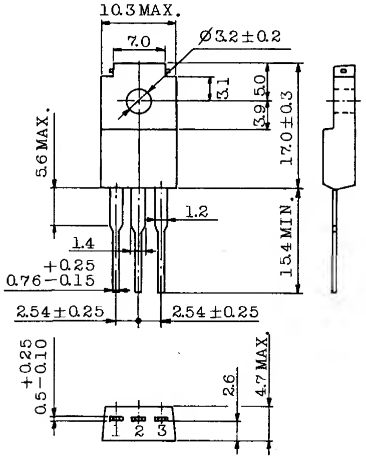
SILICON NPNEPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.4V(Max.)$ at $I_C=3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s(Typ.)$
- Complementary to 2SA1307

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

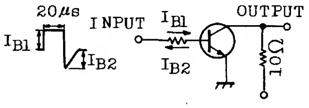
JEDEC	―
EIAJ	―
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS $(Ta=25^{\circ}C)$

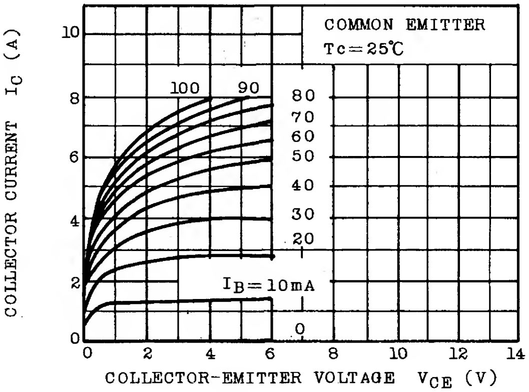
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	5	A
Base Current		I_B	1	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	2.0	W
	$Tc=25^{\circ}C$		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS $(Ta=25^{\circ}C)$

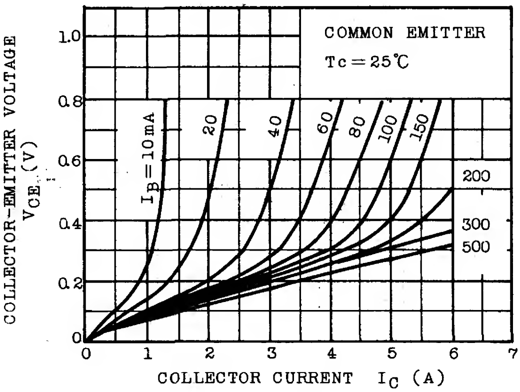
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V,\ I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V,\ I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA,\ I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V,\ I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V,\ I_C=3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A,\ I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A,\ I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V,\ I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V,\ I_E=0,\ f=1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=-I_{B2}=0.15A$ $V_{CC}=30V$ DUTY CYCLE≦1%	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

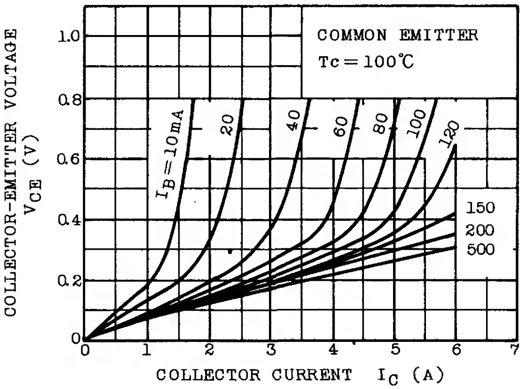
$I_C - V_{CE}$



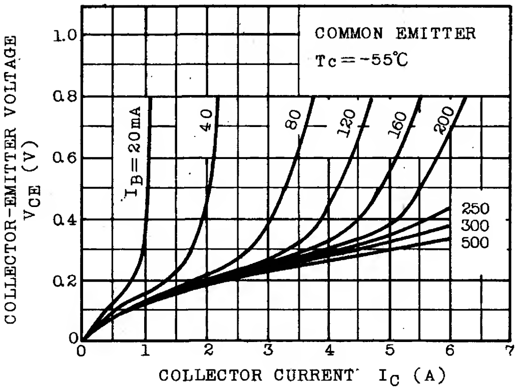
$V_{CE} - I_C$



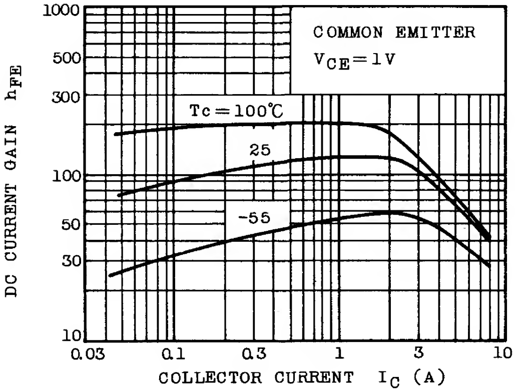
$V_{CE} - I_C$



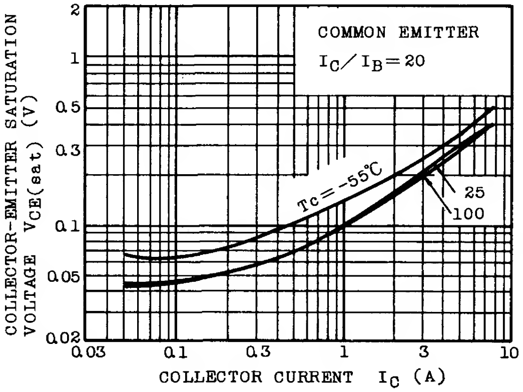
$V_{CE} - I_C$

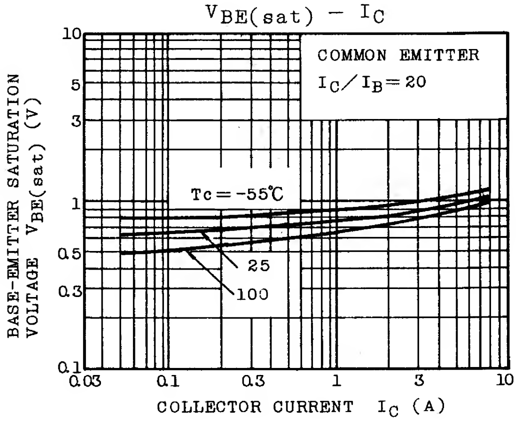


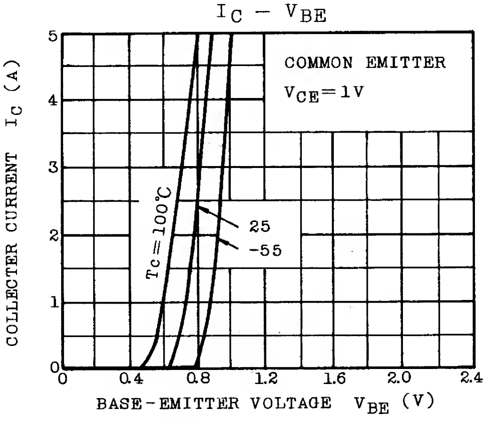
$h_{FE} - I_C$

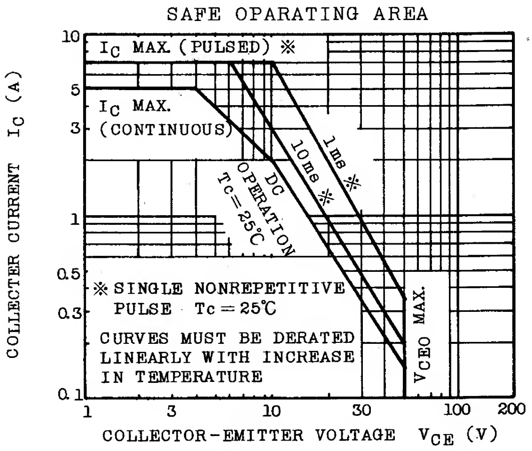


$V_{CE(sat)} - I_C$




$V_{BE(sat)}$ – I_C
COMMON EMITTER
$I_C/I_B=20$
Tc = -55℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
10
5
3
1
0.5
0.3
0.1
0.03
0.1
0.3
1
3
10
COLLECTOR CURRENT I_C (A)


I_C – V_{BE}
COMMON EMITTER
$V_{CE}=1V$
Tc = 100℃
25
-55
COLLECTER CURRENT I_C (A)
5
4
3
2
1
0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE-EMITTER VOLTAGE V_{BE} (V)

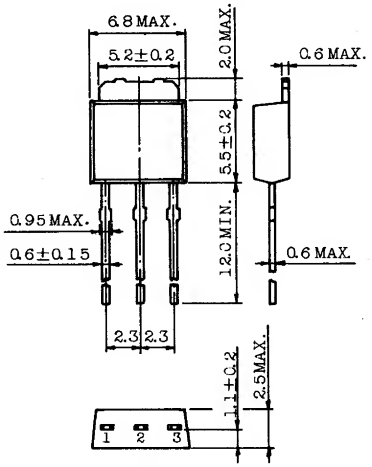

SAFE OPARATING AREA
I_C MAX. (PULSED) ※
I_C MAX. (CONTINUOUS)
1ms ※
10ms ※
DC OPERATION Tc = 25℃
V_{CEO} MAX.
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTER CURRENT I_C (A)
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
200
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3303

HIGH CURRENT SWITCHING APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-7B1A

Weight : 0.36g

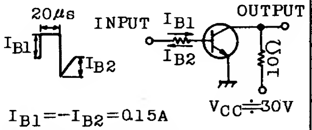
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.4V$ (Max.) at $I_C=3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$ (Typ.)

MAXIMUM RATINGS ($Ta=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	8	
Base Current		I_B	1	A
Collector Power Dissipation ($Tc=25^\circ C$)		P_C	20	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS ($Ta=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V$, $I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C-10mA, $I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V$, $I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V$, $I_C=3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A$, $I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A$, $I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V$, $I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 10Ω V_{CC}≒30V $I_{B1}=-I_{B2}=0.15A$ DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

2SC3306

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATIONS.

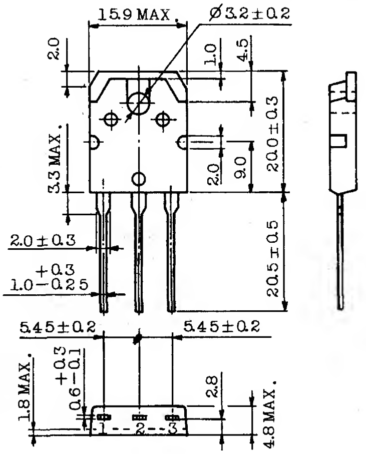
FEATURES:

. Excellent Switching Times
  : t_r=1.0μs (Max.), t_f=1.0μs (Max.) (I_C=5A)

. High Collector Breakdown Voltage : V_{CEO}=400V

INDUSTRIAL APPLICATIONS

Unit in mm



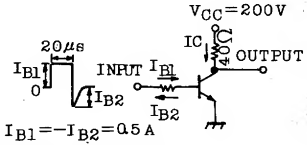
1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16C1A

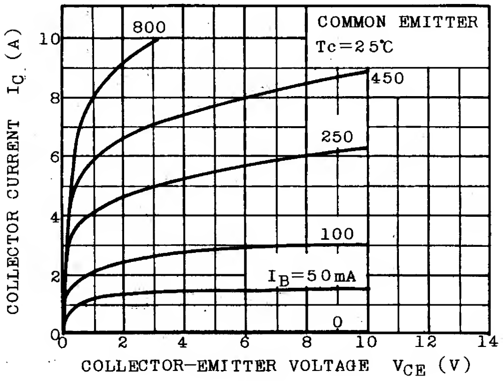
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	
Base Current		I_B	5	A
Collector Power Dissipation (Tc=25°C)		P_C	100	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55~150	°C

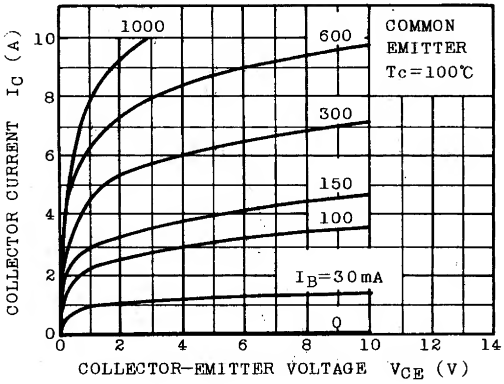
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	7	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=5A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Switching Time	Rise Time	t_r	 V_{CC}=200V IC 40Ω OUTPUT 20μs I_{B1} 0 I_{B2} INPUT I_{B1} I_{B2} I_{B1}=−I_{B2}=0.5A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

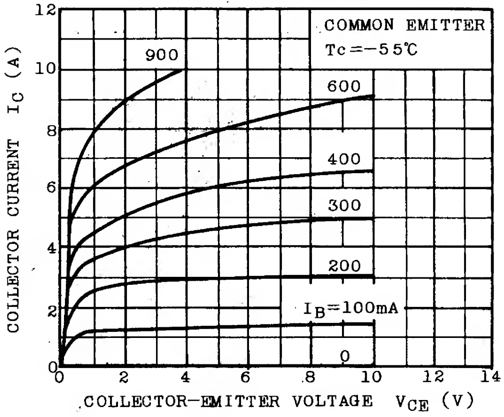
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



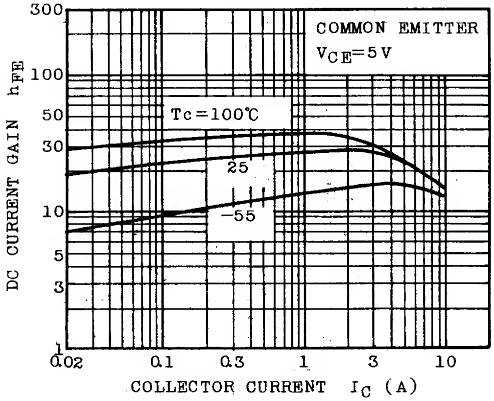
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



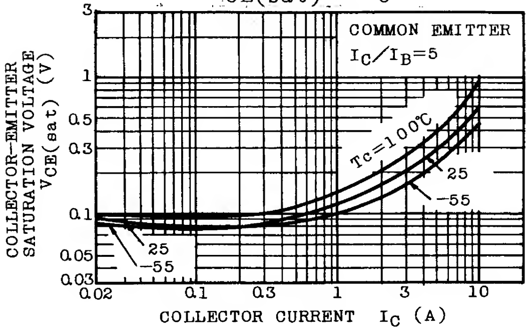
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



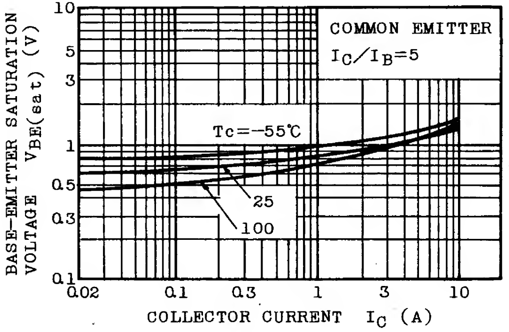
$h_{FE} - I_C$



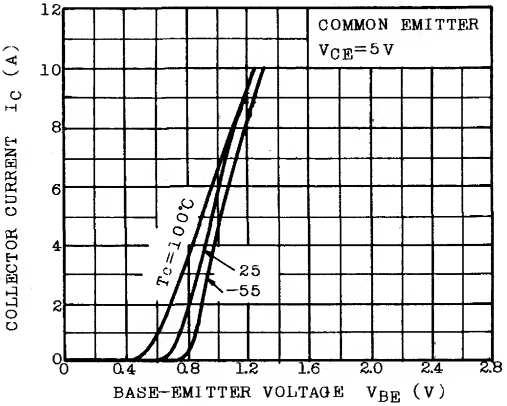
$V_{CE(sat)} - I_C$



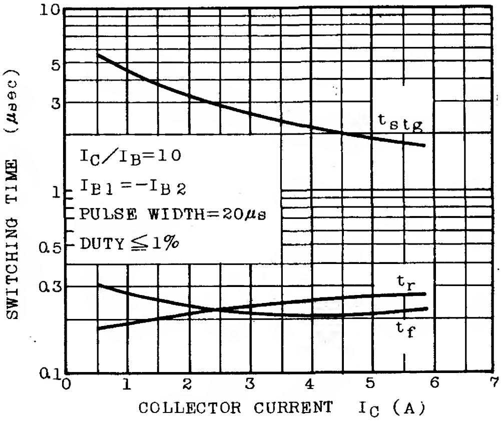
$V_{BE(sat)} - I_C$



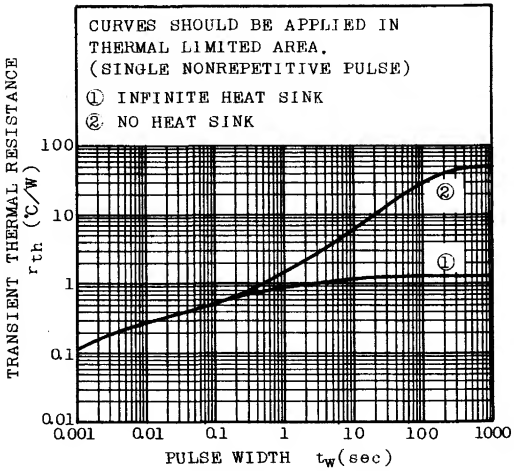
$I_C - V_{BE}$



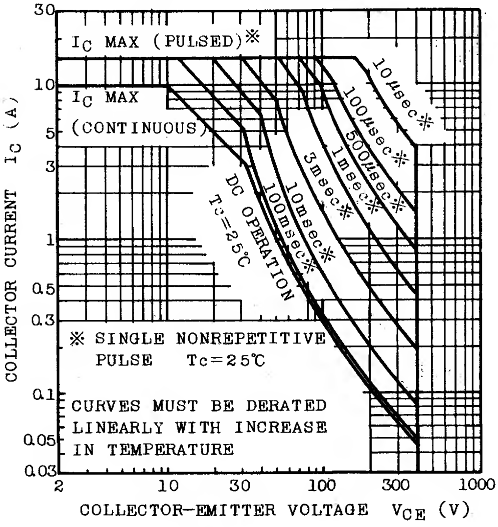
SWITCHING CHARACTERISTICS



$r_{th} - t_w$



SAFE OPERATING AREA



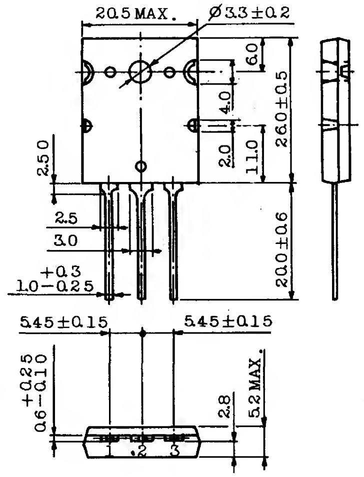
SILICON NPN TRIPLE DIFFUSED TYPE

2SC3307

HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−21F1A

Weight : 9.8g

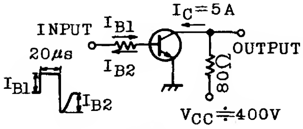
FEATURES:

- Excellent Switching Times : t_r=1.0μs (Max.), t_f=1.0μs (Max.) (I_C=5A)
- High Collector Breakdown Voltage : V_{CEO}=800V

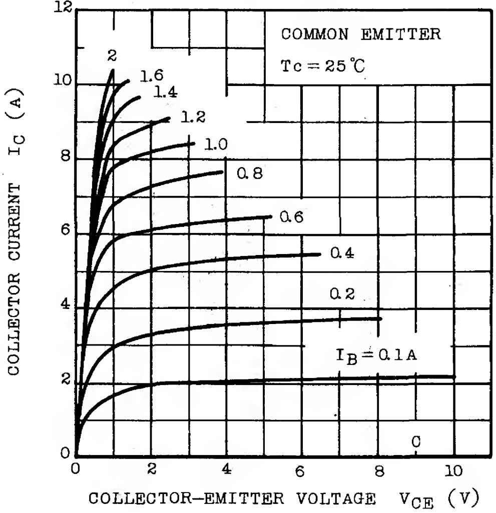
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	
Base Current		I_B	3	A
Collector Power Dissipation (Tc=25°C)		P_C	150	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

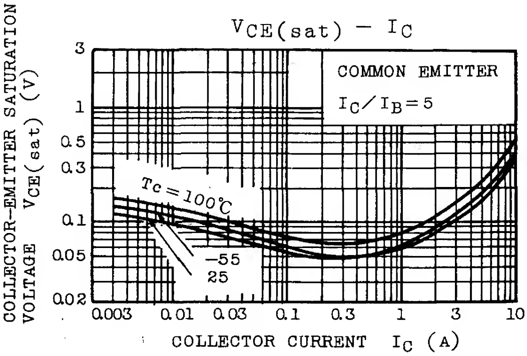
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=10mA	10	-	-	-
		$h_{FE(2)}$	V_{CE}=5V, I_C=5A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Switching Time	Rise Time	t_r	 I_C=5A INPUT I_{B1} 20μs I_{B2} OUTPUT 80Ω I_{B1} I_{B2} V_{CC}≑400V DUTY CYCLE≦1% $3I_{B1}=-I_{B2}$=1.5A	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	3.0	
	Fall Time	t_f		-	-	1.0	

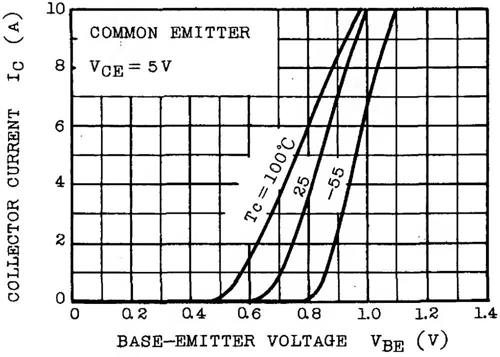
$I_C - V_{CE}$



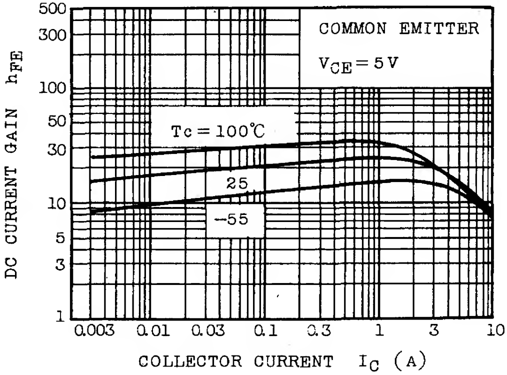
$V_{CE(sat)} - I_C$



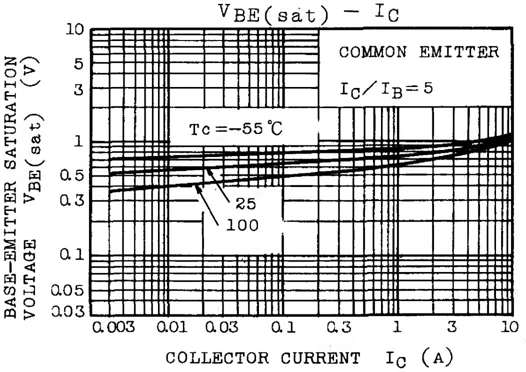
$I_C - V_{BE}$



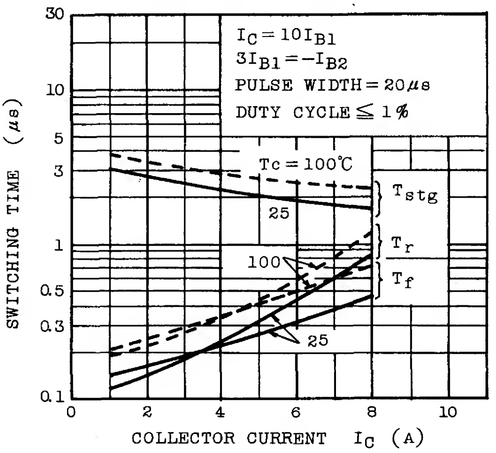
$h_{FE} - I_C$

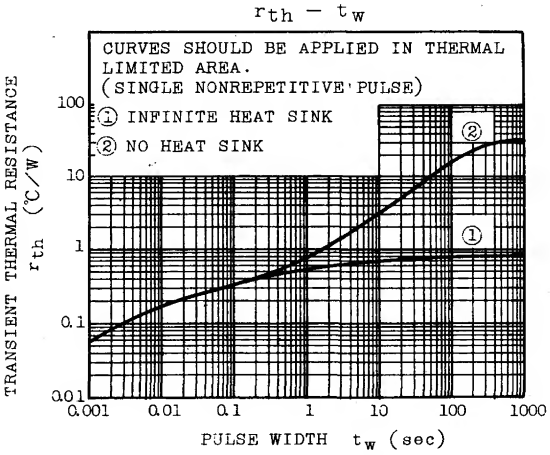


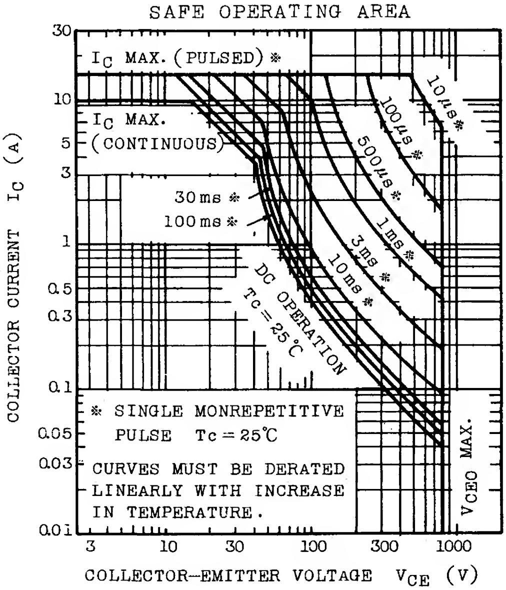
$V_{BE(sat)} - I_C$



SWITCHING TIME $- I_C$




$r_{th} - t_w$
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA.
(SINGLE NONREPETITIVE PULSE)
① INFINITE HEAT SINK
② NO HEAT SINK
①
②
TRANSIENT THERMAL RESISTANCE r_{th} (℃/W)
100
10
1
0.1
0.01
0.001
0.01
0.1
1
10
100
1000
PULSE WIDTH t_w (sec)


SAFE OPERATING AREA
I_C MAX. (PULSED) ※
I_C MAX. (CONTINUOUS)
10 μs ※
100 μs ※
500 μs ※
1 ms ※
3 ms ※
10 ms ※
30 ms ※
100 ms ※
DC OPERATION Tc = 25℃
※ SINGLE MONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
3
10
30
100
300
1000
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

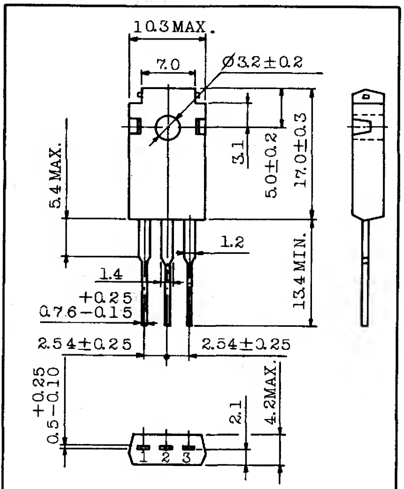
2SC3308

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-10K1A

Weight : 2.0g

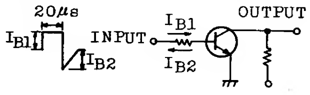
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.4V$(Max.) at $I_C=3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$(Typ.)
- Complementary to 2SA1308.

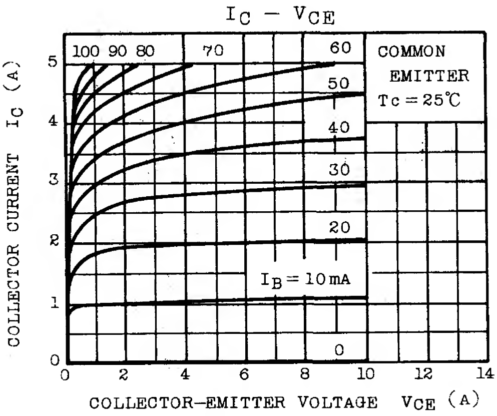
MAXIMUM RATINGS (Ta=25°C)

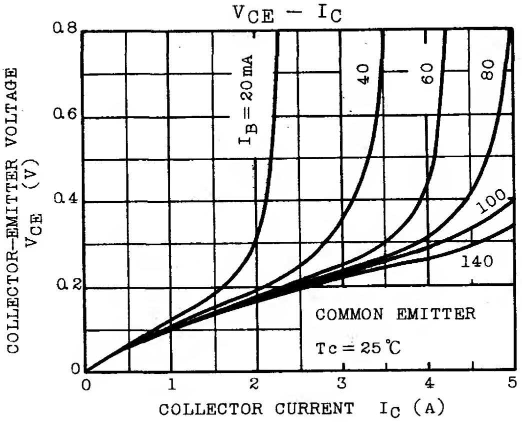
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	8	
Collector Power Dissipation (Tc=25°C)		P_C	30	V
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

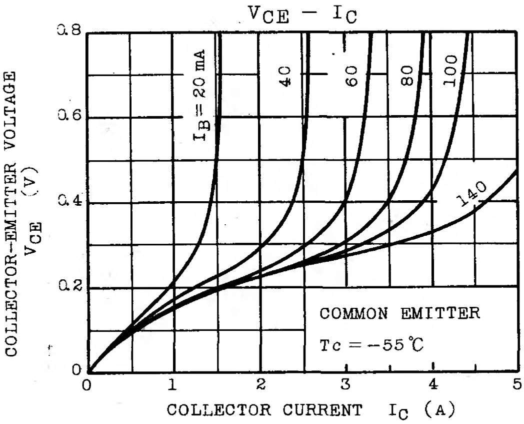
ELECTRICAL CHARACTERISTICS (Ta=25°C)

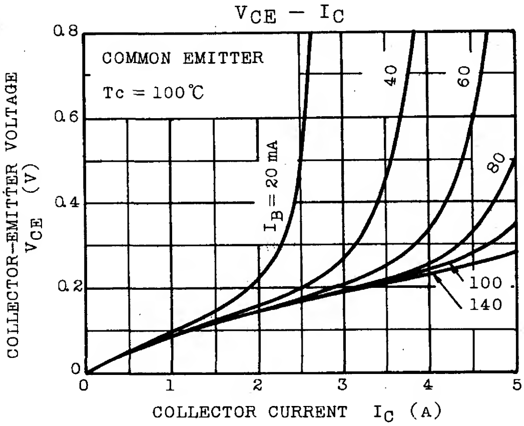
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V,\ I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V,\ I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA,\ I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V,\ I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V,\ I_C=3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A,\ I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A,\ I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V,\ I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V,\ I_E=0,\ f=1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} INPUT I_{B1} I_{B2} I_{B2} OUTPUT $I_{B1}=-I_{B2}=0.15A$ $V_{CC}≑30V$ DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

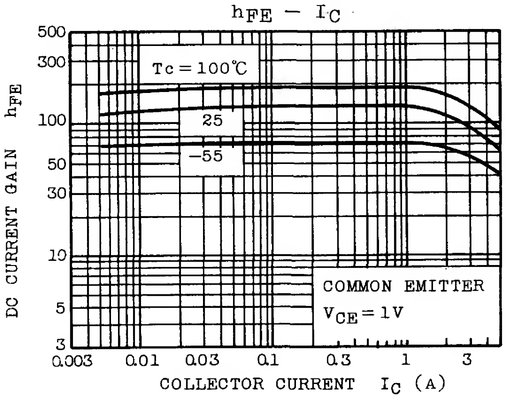
Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

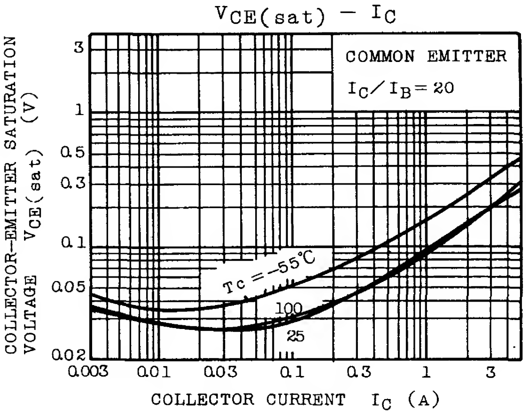

IC − VCE
COMMON EMITTER
Tc = 25℃
100 90 80
70
60
50
40
30
20
IB = 10 mA
0
COLLECTOR CURRENT IC (A)
0
1
2
3
4
5
0
2
4
6
8
10
12
14
COLLECTOR−EMITTER VOLTAGE VCE (A)

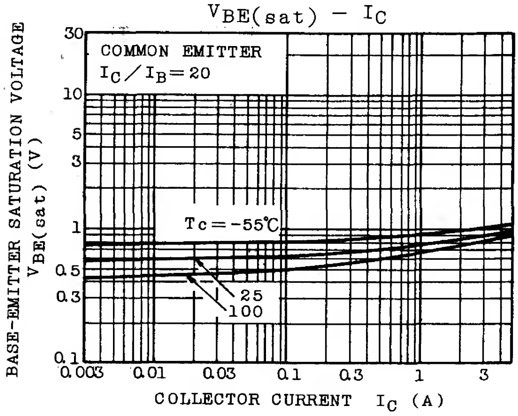

VCE − IC
IB = 20 mA
40
60
80
100
140
COMMON EMITTER
Tc = 25 ℃
COLLECTOR−EMITTER VOLTAGE VCE (V)
0
0.2
0.4
0.6
0.8
0
1
2
3
4
5
COLLECTOR CURRENT IC (A)

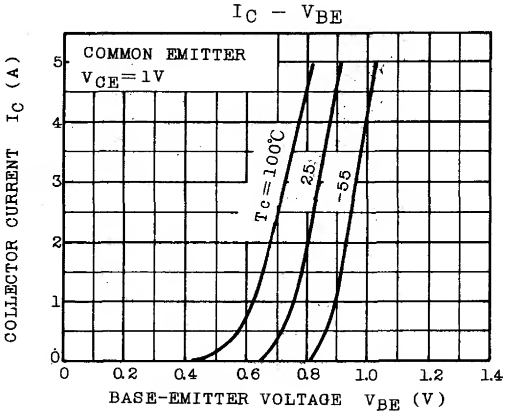

VCE − IC
IB = 20 mA
40
60
80
100
140
COMMON EMITTER
Tc = −55 ℃
COLLECTOR−EMITTER VOLTAGE VCE (V)
0
0.2
0.4
0.6
0.8
0
1
2
3
4
5
COLLECTOR CURRENT IC (A)

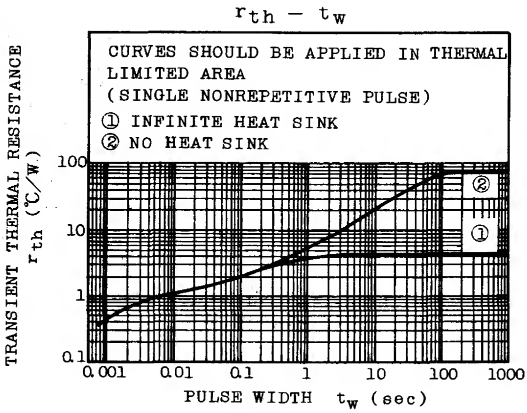

VCE − IC
COMMON EMITTER
Tc = 100 ℃
IB = 20 mA
40
60
80
100
140
COLLECTOR−EMITTER VOLTAGE VCE (V)
0
0.2
0.4
0.6
0.8
0
1
2
3
4
5
COLLECTOR CURRENT IC (A)

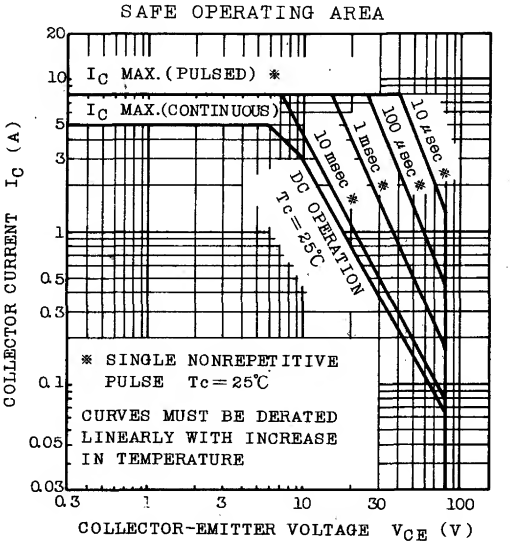

hFE − IC
Tc = 100℃
25
−55
COMMON EMITTER
VCE = 1V
DC CURRENT GAIN hFE
3
5
10
30
50
100
300
500
0.003
0.01
0.03
0.1
0.3
1
3
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC/IB = 20
Tc = −55℃
100
25
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
0.02
0.05
0.1
0.3
0.5
1
3
0.003
0.01
0.03
0.1
0.3
1
3
COLLECTOR CURRENT IC (A)


VBE(sat) – IC
COMMON EMITTER
IC/IB=20
Tc=-55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
30
10
5
3
1
0.5
0.3
0.1
0.003
0.01
0.03
0.1
0.3
1
3
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=1V
Tc=100℃
25
-55
COLLECTOR CURRENT IC (A)
5
4
3
2
1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE-EMITTER VOLTAGE VBE (V)


rth – tw
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA
(SINGLE NONREPETITIVE PULSE)
① INFINITE HEAT SINK
② NO HEAT SINK
②
①
TRANSIENT THERMAL RESISTANCE rth (℃/W)
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
PULSE WIDTH tw (sec)


SAFE OPERATING AREA
IC MAX.(PULSED) ※
IC MAX.(CONTINUOUS)
10 μsec ※
100 μsec ※
1 msec ※
10 msec ※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.3
1
3
10
30
100
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE

2SC3309

INDUSTRIAL APPLICATIONS

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

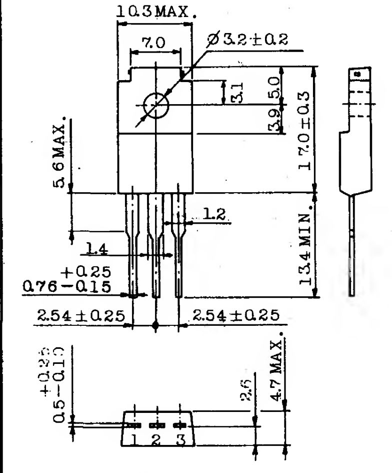
FEATURES:

. Excellent Switching Times

t_r=1.0µs(Max.), t_f=1.0µs(Max.) at I_C=0.8A

. High Collector Breakdown Voltage : V_{CEO}=400V

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

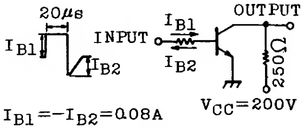
JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

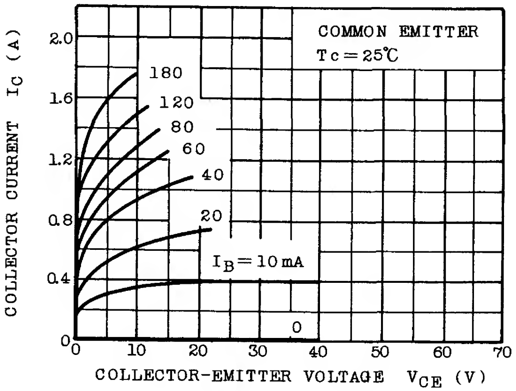
Weight : 2.1g

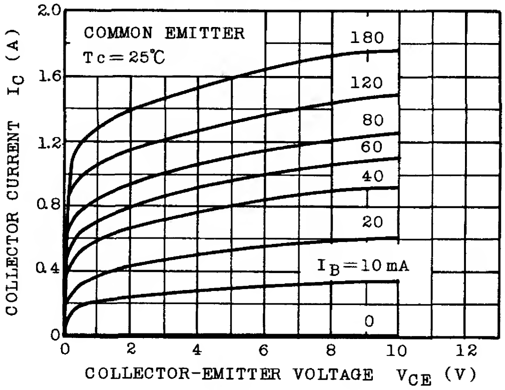
MAXIMUM RATINGS (Ta=25°C)

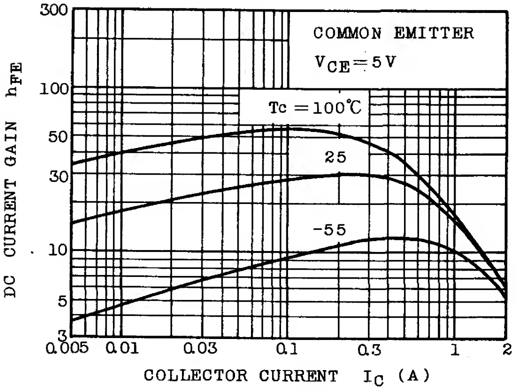
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		20	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~150	°C

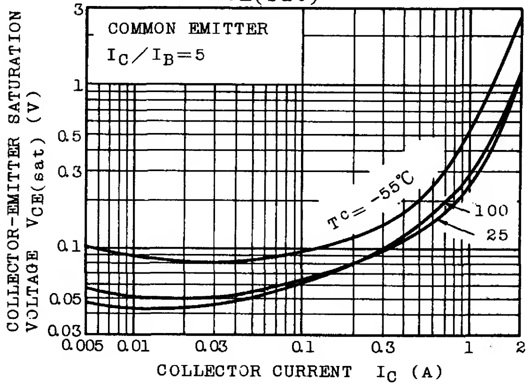
ELECTRICAL CHARACTERISTICS (Ta=25°C)

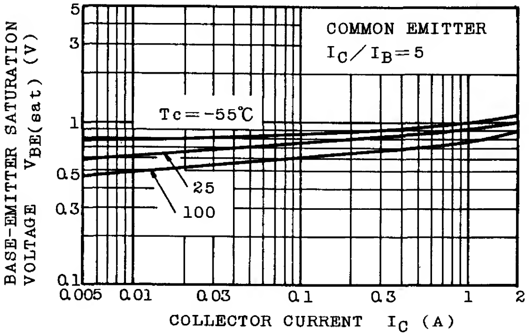
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	µA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.1A	20	-	-	
			V_{CE}=5V, I_C=1A	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=0.2A	-	-	1.5	V
Switching Time	Rise Time	t_r	 20µs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 250Ω V_{CC}=200V I_{B1}=−I_{B2}=0.08A DUTY CYCLE<1%	-	-	1.0	µs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

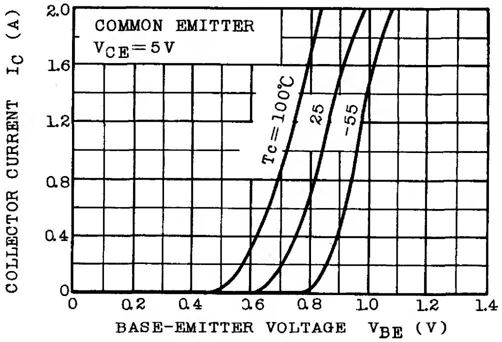

STATIC CHARACTERISTICS


I_C – V_{CE} (LOW VOLTAGE REGION)

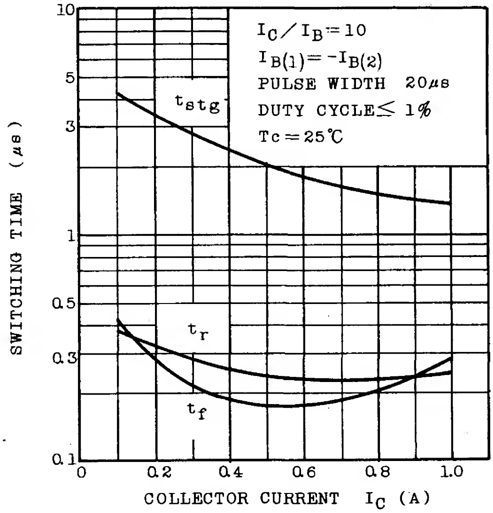

h_{FE} – I_C


$V_{CE(sat)}$ – I_C

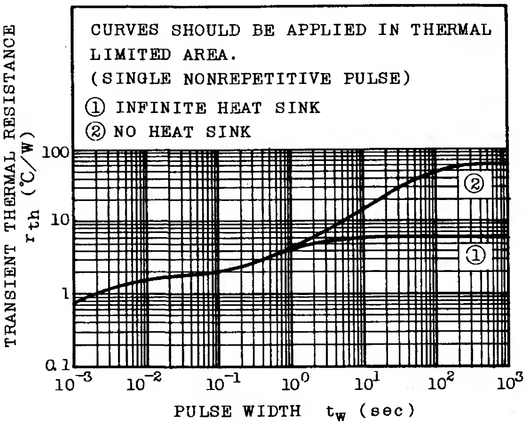

$V_{BE(sat)}$ – I_C


I_C – V_{BE}

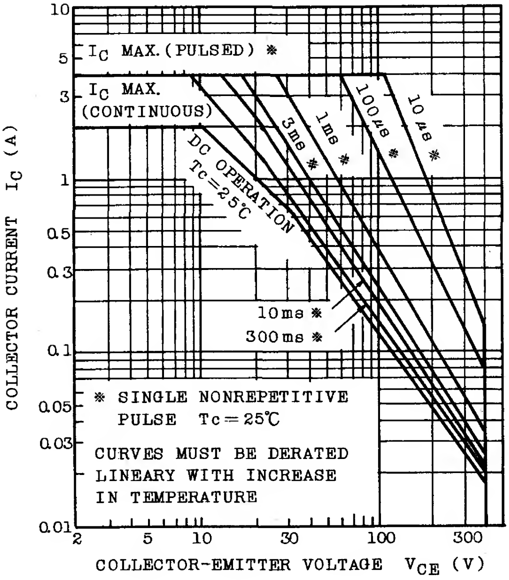
SWITCHING CHARACTERISTICS



$r_{th} - t_w$



SAFE OPERATING AREA



2SC3310

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

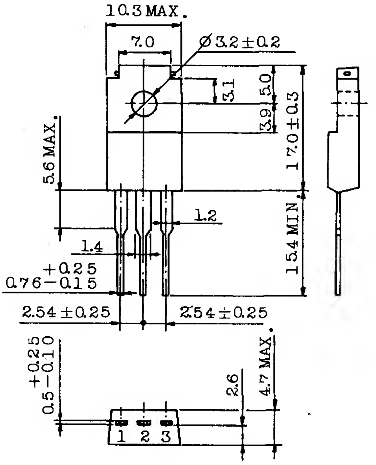
FEATURES:

. Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=4A

. High Collector Breakdown Voltage : V_{CEO}=400V

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

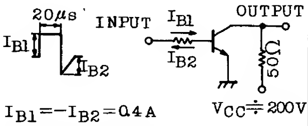
JEDEC	―
EIAJ	―
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	7	
Base Current		I_B	1	A
Collector Power Dissipation	T_a=25°C	P_C	2.0	W
	T_c=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	–	–	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	–	–	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	–	–	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	–	–	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=3A	12	–	–	
			V_{CE}=5V, I_C=5A	8	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	–	–	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=1A	–	–	1.5	V
Switching Time	Rise Time	t_r	 20μs INPUT I_{B1} I_{B2} I_{B1} I_{B2} OUTPUT 50Ω V_{CC}≒200V I_{B1}=−I_{B2}=0.4A DUTY CYCLE<1%	–	–	1.0	μs
	Storage Time	t_{stg}		–	–	2.5	
	Fall Time	t_f		–	–	1.0	

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

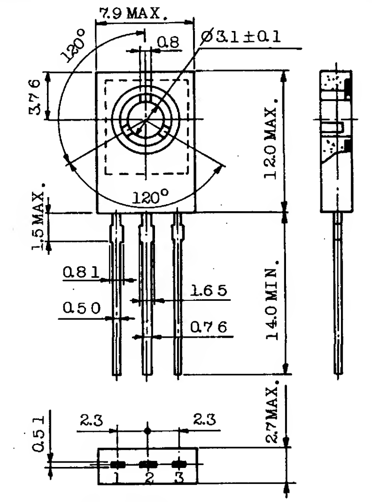
2SC3335

HIGH VOLTAGE SWITCHING APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=250V
- Low Cre : 2.0pF(Max.)
- Complementary to 2SA1322

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	–
TOSHIBA	2-8F1A

Weight : 0.72g
Mounting Kit No. AC46C

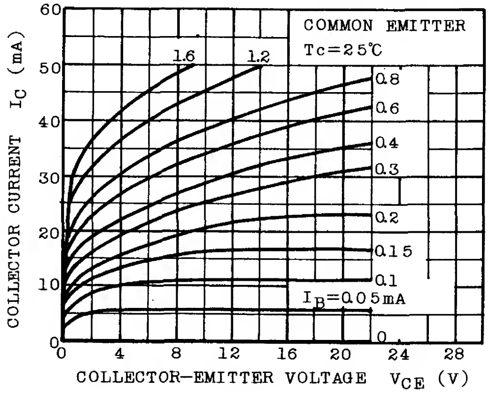
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	250	V
Collector-Emitter Voltage		V_{CEO}	250	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	50	mA
	Peak	I_{CP}	100	
Base Current		I_B	20	mA
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	Tc=25°C		10.0	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

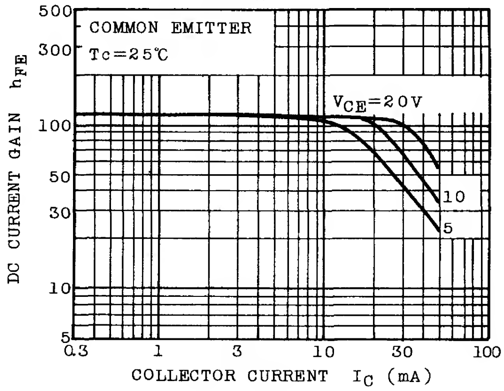
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=1mA, I_B=0	250	-	-	V
DC Current Gain	h_{FE}	V_{CE}=20V, I_C=25mA	50	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10mA, I_B=1mA	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=20V, I_C=25mA	-	0.75	-	V
Transition Frequency	f_T	V_{CE}=10V, I_C=10mA	60	100	-	MHz
Reverse Transfer Capacitance	C_{re}	V_{CB}=30V, I_E=0, f=1MHz	-	-	2.0	pF

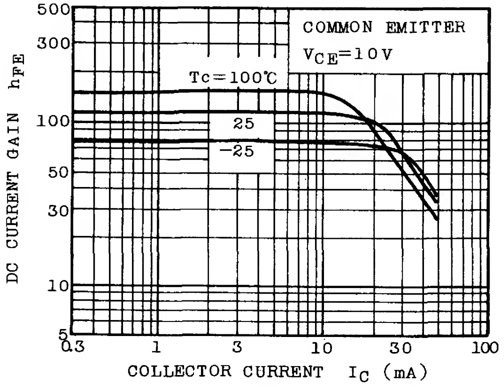
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



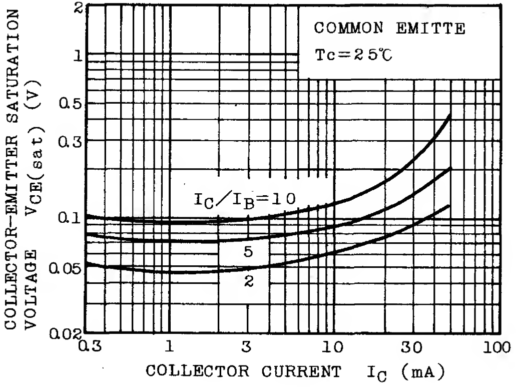
$h_{FE} - I_C$



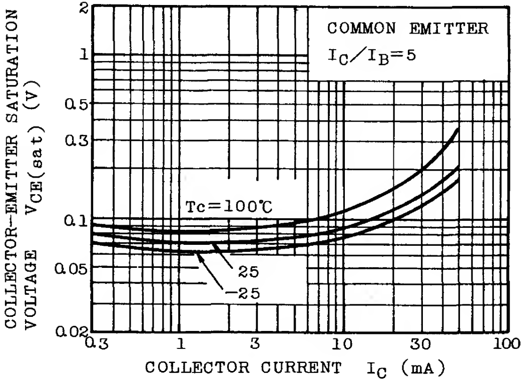
$h_{FE} - I_C$



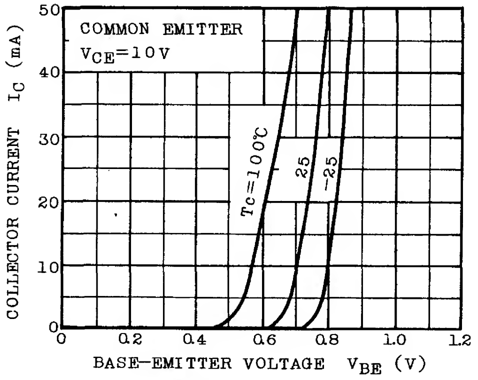
$V_{CE(sat)} - I_C$

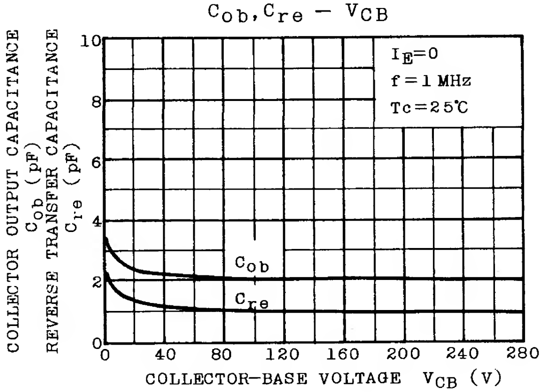


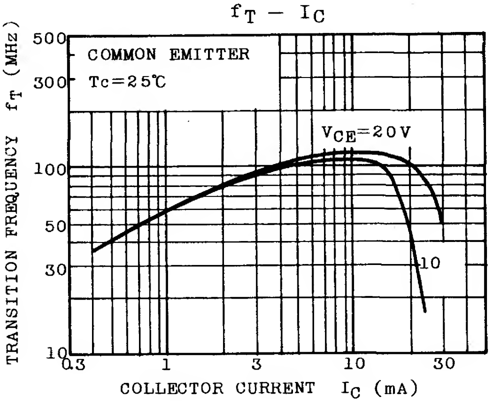
$V_{CE(sat)} - I_C$

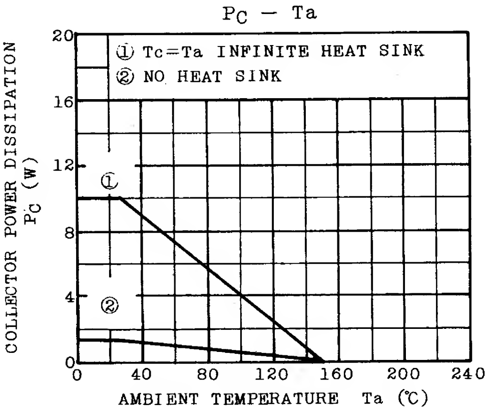


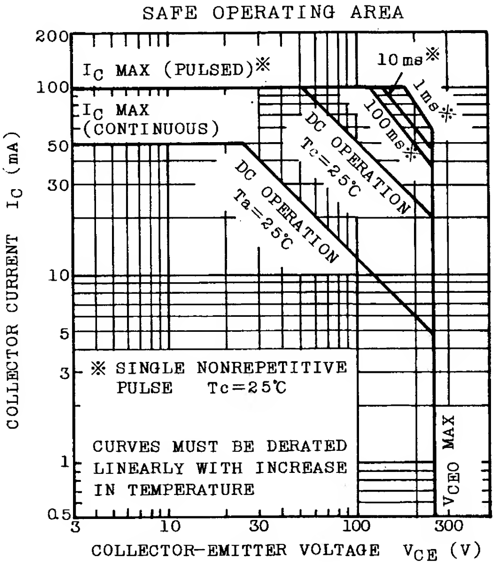
$I_C - V_{BE}$




Cob, Cre — VCB
IE=0
f=1 MHz
Tc=25℃
Cob
Cre
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
REVERSE TRANSFER CAPACITANCE Cre (pF)
COLLECTOR-BASE VOLTAGE VCB (V)
0
2
4
6
8
10
0
40
80
120
160
200
240
280


fT — IC
COMMON EMITTER
Tc=25℃
VCE=20V
10
TRANSITION FREQUENCY fT (MHz)
COLLECTOR CURRENT IC (mA)
10
30
50
100
300
500
0.3
1
3
10
30


PC — Ta
① Tc=Ta INFINITE HEAT SINK
② NO HEAT SINK
①
②
COLLECTOR POWER DISSIPATION PC (W)
AMBIENT TEMPERATURE Ta (℃)
0
4
8
12
16
20
0
40
80
120
160
200
240


SAFE OPERATING AREA
IC MAX (PULSED)※
10ms※
1ms※
100ms※
IC MAX (CONTINUOUS)
DC OPERATION Tc=25℃
DC OPERATION Ta=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (mA)
COLLECTOR-EMITTER VOLTAGE VCE (V)
0.5
1
3
5
10
30
50
100
200
3
10
30
100
300

2SC3344

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

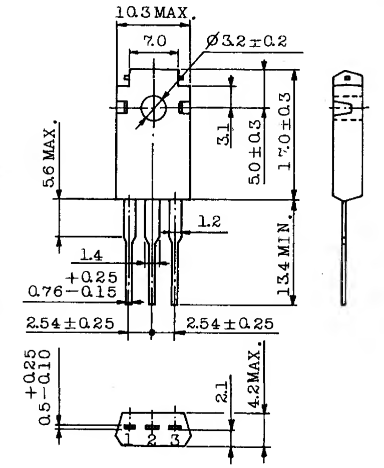
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
  : t_r=1.0μs(Max.), t_f=1.0μs(Max.) at I_C=4A
- High Collector Breakdown Voltage : V_{CEO}=400V

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

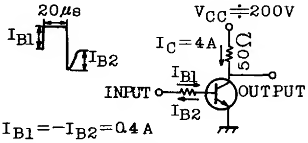
JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

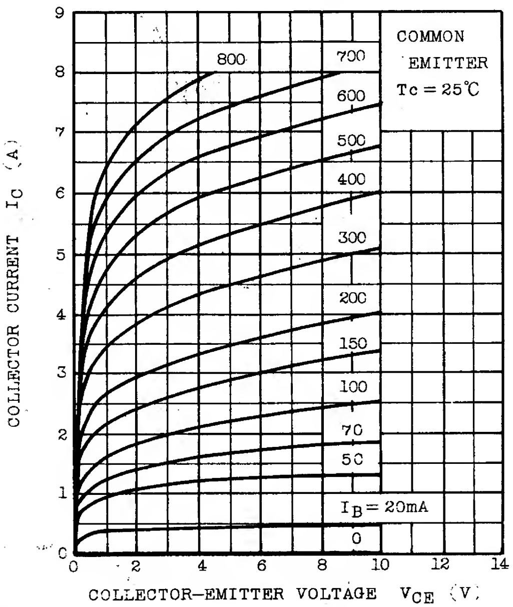
Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

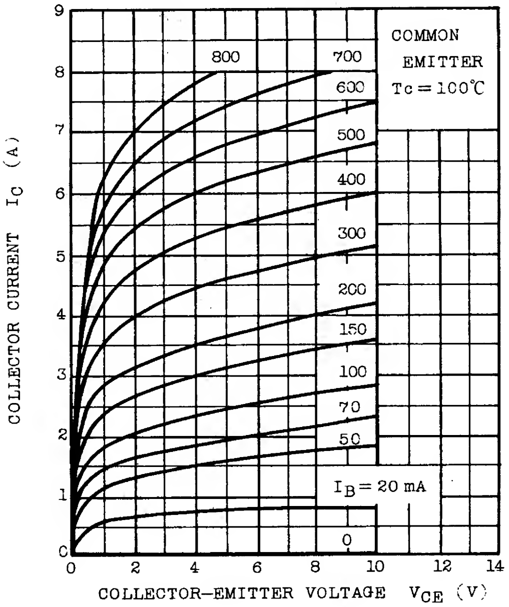
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	8	A
	Pulse	I_{CP}	10	
Base Current		I_B	4	A
Collector Power Dissipation	Ta=25°C	P_C	1.7	W
	Tc=25°C		60	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

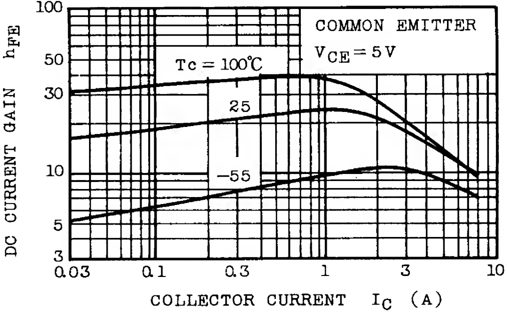
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=400V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=1A	15	-	-	
		$h_{FE(2)}$	V_{CE}=5V, I_C=4A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.5	V
Switching Time	Rise Time	t_r	 I_{B1}=−I_{B2}=0.4A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	



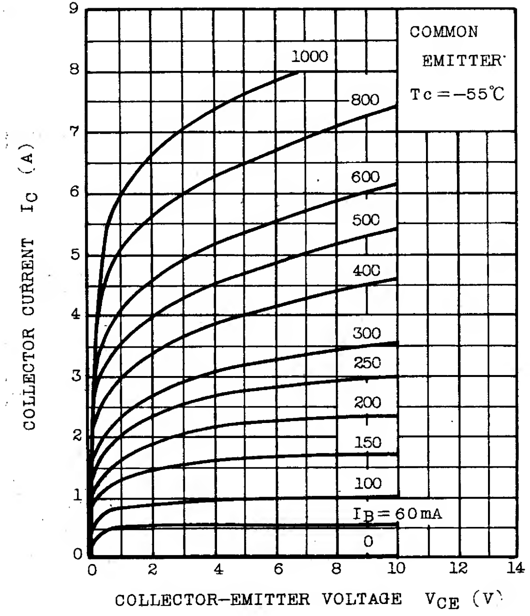
$I_C - V_{CE}$



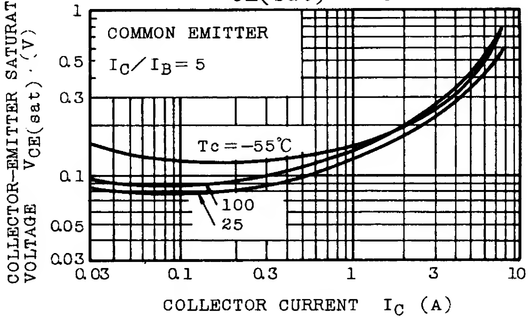
$I_C - V_{CE}$



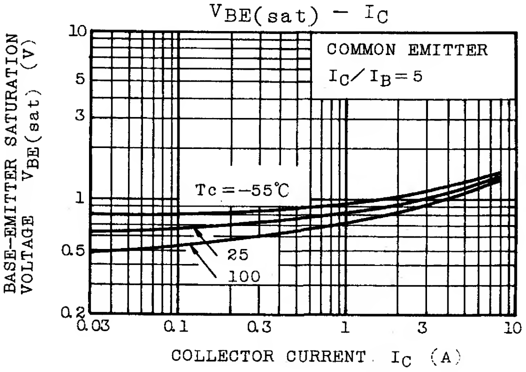
$h_{FE} - I_C$

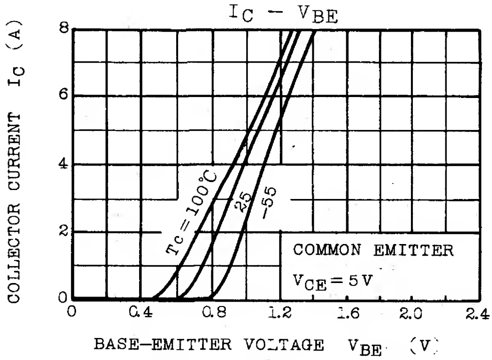


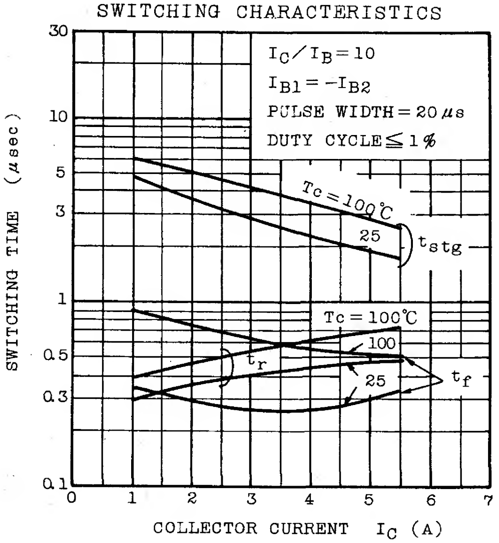
$I_C - V_{CE}$

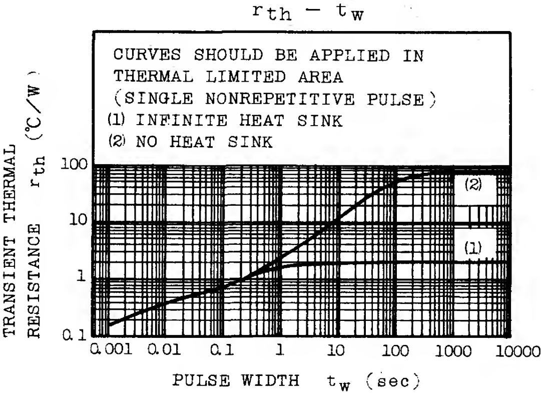


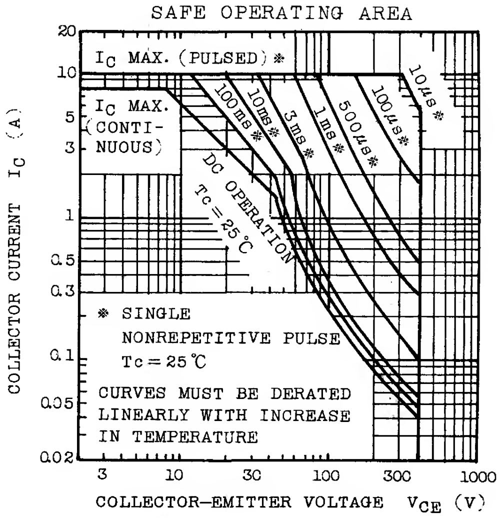
$V_{CE(sat)} - I_C$


VBE(sat) – IC
COMMON EMITTER
IC/IB = 5
Tc = −55°C
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
10
5
3
1
0.5
0.2
0.03
0.1
0.3
1
3
10
COLLECTOR CURRENT IC (A)


IC – VBE
Tc = 100°C
25
−55
COMMON EMITTER
VCE = 5V
COLLECTOR CURRENT IC (A)
8
6
4
2
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE-EMITTER VOLTAGE VBE (V)


SWITCHING CHARACTERISTICS
IC/IB = 10
IB1 = −IB2
PULSE WIDTH = 20 μs
DUTY CYCLE ≦ 1%
Tc = 100°C
25
tstg
Tc = 100°C
100
tr
25
tf
SWITCHING TIME (μsec)
30
10
5
3
1
0.5
0.3
0.1
0
1
2
3
4
5
6
7
COLLECTOR CURRENT IC (A)


rth – tw
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA
(SINGLE NONREPETITIVE PULSE)
(1) INFINITE HEAT SINK
(2) NO HEAT SINK
(2)
(1)
TRANSIENT THERMAL RESISTANCE rth (°C/W)
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
10000
PULSE WIDTH tw (sec)

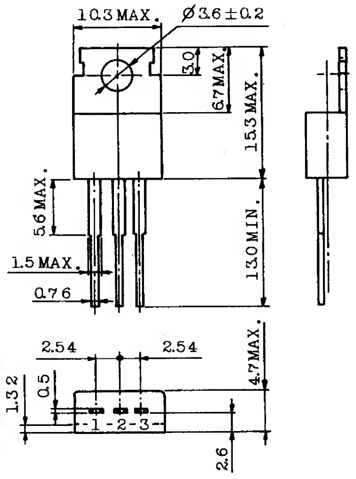

SAFE OPERATING AREA
IC MAX. (PULSED)*
IC MAX. (CONTINUOUS)
10μs*
100μs*
500μs*
1ms*
3ms*
10ms*
100ms*
DC OPERATION Tc = 25°C
* SINGLE NONREPETITIVE PULSE Tc = 25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.02
3
10
30
100
300
1000
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3345

HIGH CURRENT SWITCHING APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75
Weight : 1.9g

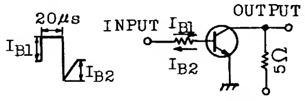
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) (at I_C=6A)
- High Speed Switching Time : t_{stg}=1.0μs(Typ.)
- Complementary to 2SA1328

MAXIMUM RATINGS (Ta=25°C)

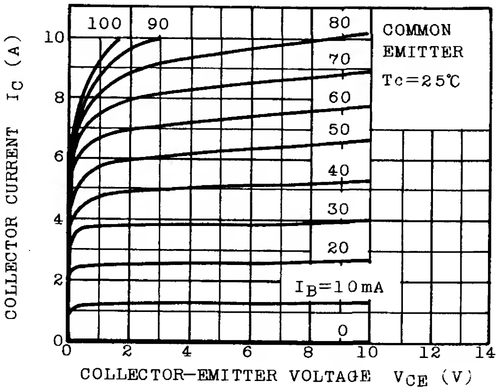
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	12	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

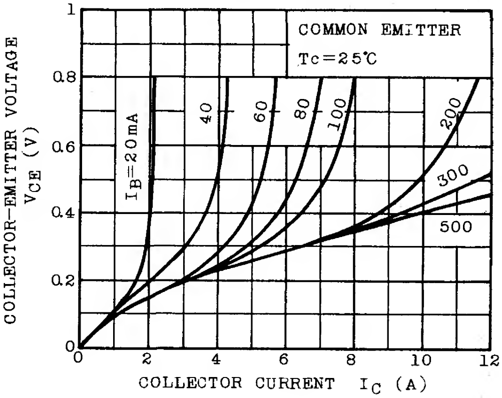
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=6A	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=6A, I_B=0.3A	-	0.25	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=6A, I_B=0.3A	-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=5V, I_C=1A	-	90	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	180	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=−I_{B2}=0.3A V_{CC}=30V DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.2	-	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

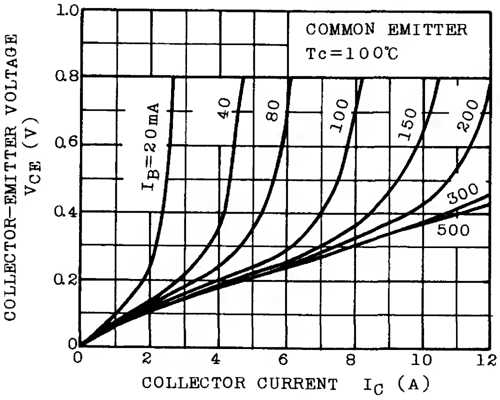
$I_C - V_{CE}$



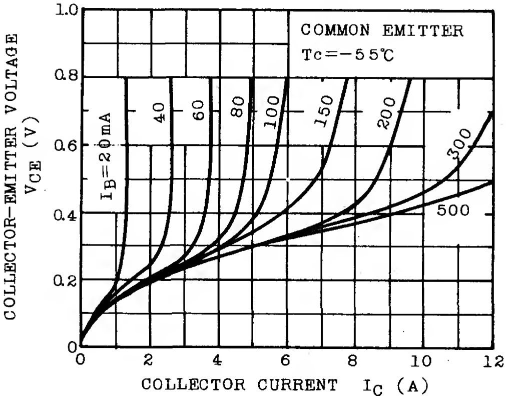
$V_{CE} - I_C$



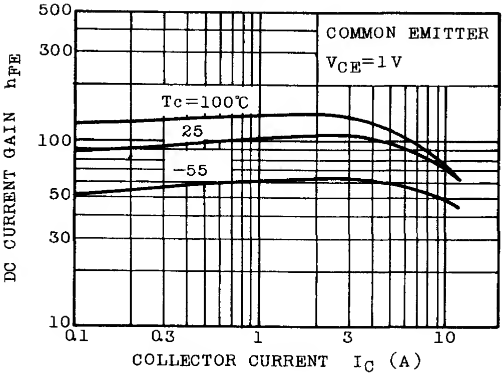
$V_{CE} - I_C$



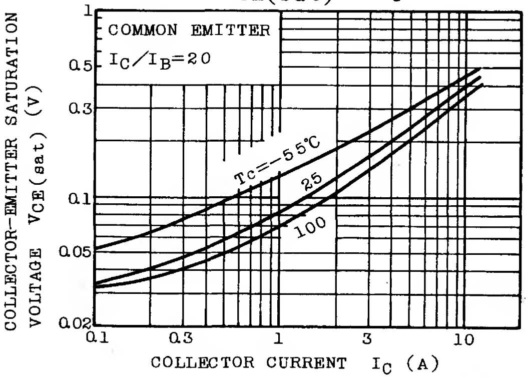
$V_{CE} - I_C$

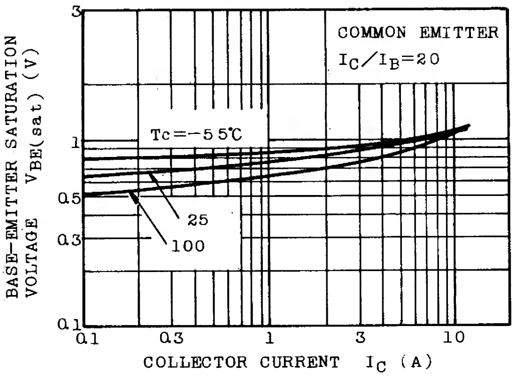


$h_{FE} - I_C$

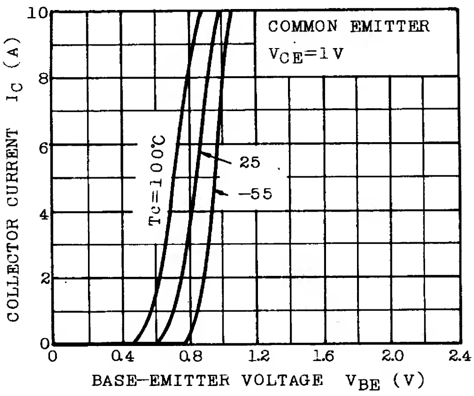


$V_{CE(sat)} - I_C$

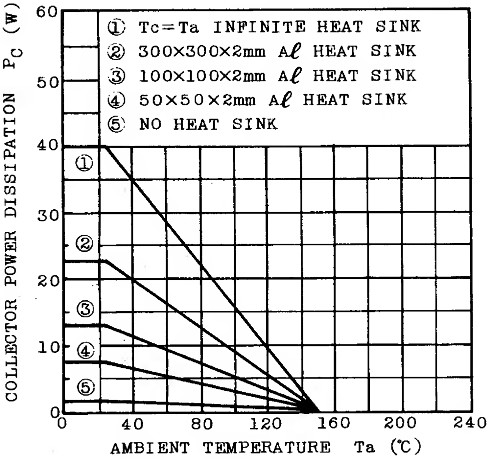




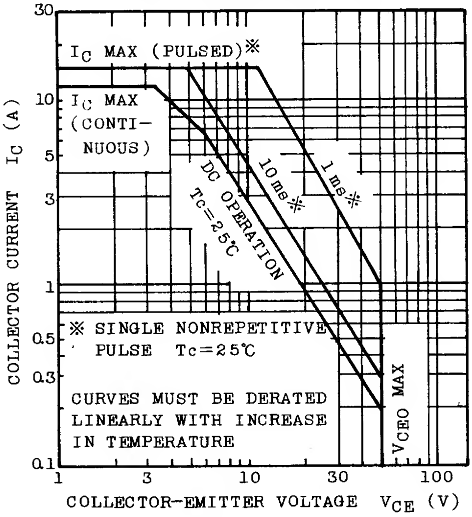
$V_{BE(sat)} - I_C$



$I_C - V_{BE}$



$P_C - Ta$



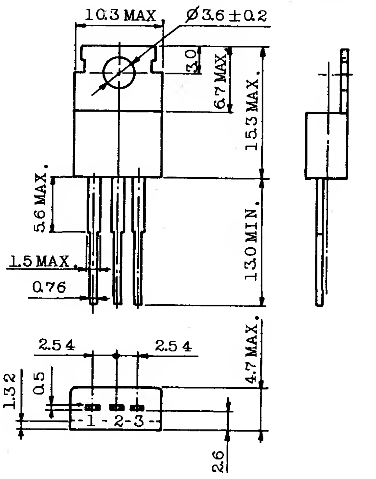
SAFE OPERATING AREA

2SC3346

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75
Weight : 1.9g

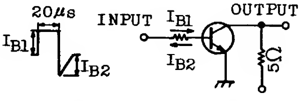
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.4V$ (Max.) (at $I_C=6A$)
- High Speed Switching Time : $t_{stg}=1.0\mu s$ (Typ.)
- Complementary to 2SA1329

MAXIMUM RATINGS (Ta=25°C)

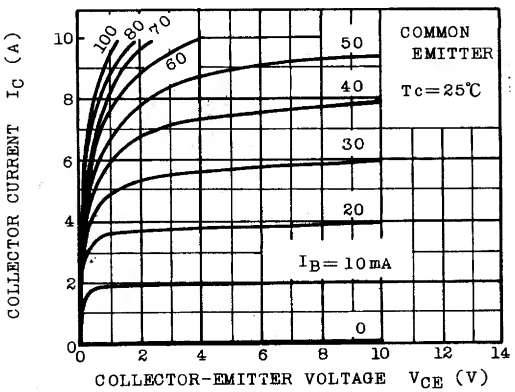
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	12	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

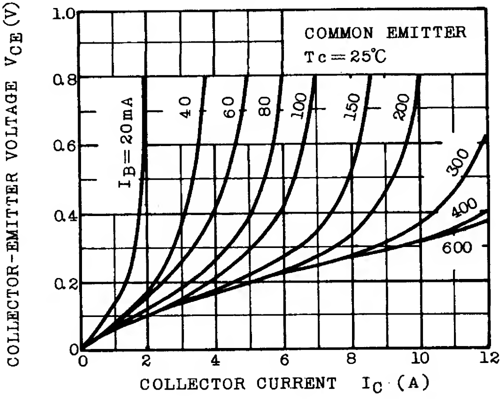
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=80V,\ I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V,\ I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA,\ I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V,\ I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V,\ I_C=6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=6A,\ I_B=0.3A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=6A,\ I_B=0.3A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=5V,\ I_C=1A$	-	80	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V,\ I_E=0,\ f=1MHz$	-	220	-	pF
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=-I_{B2}=0.3A$ $V_{CC}=30V$ DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.2	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

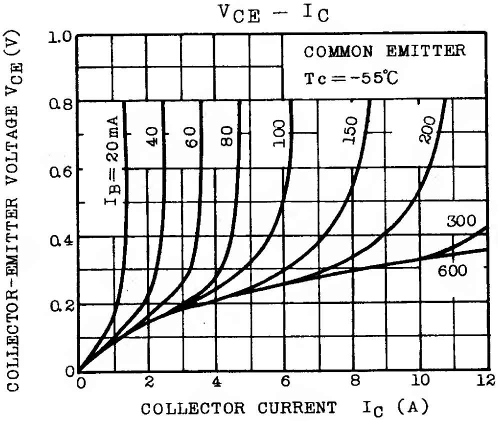
I_C – V_{CE}



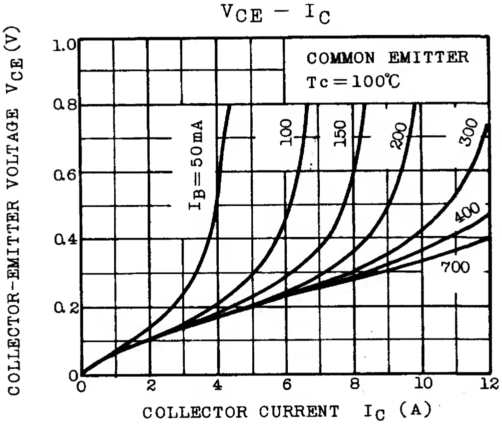
V_{CE} – I_C



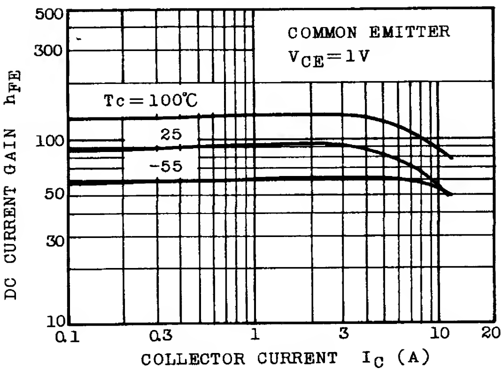
V_{CE} – I_C



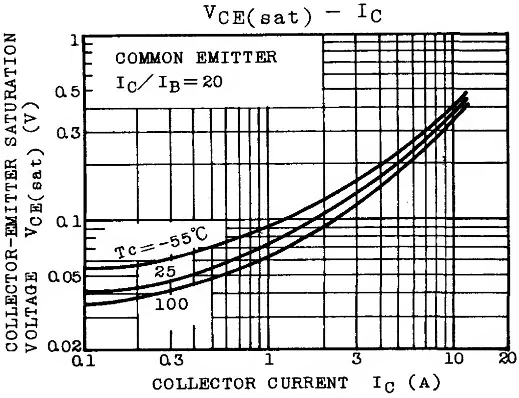
V_{CE} – I_C



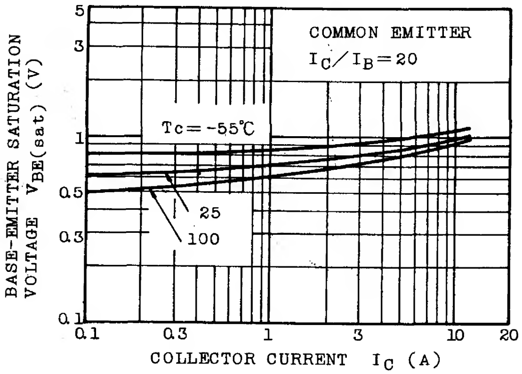
h_{FE} – I_C



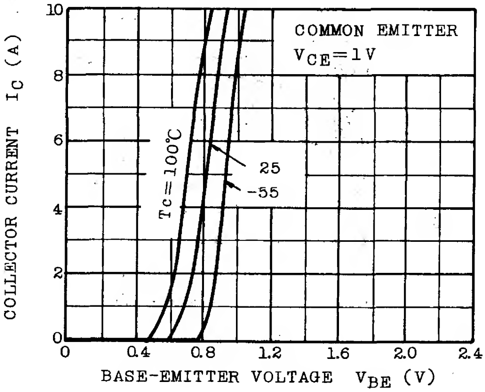
$V_{CE(sat)}$ – I_C



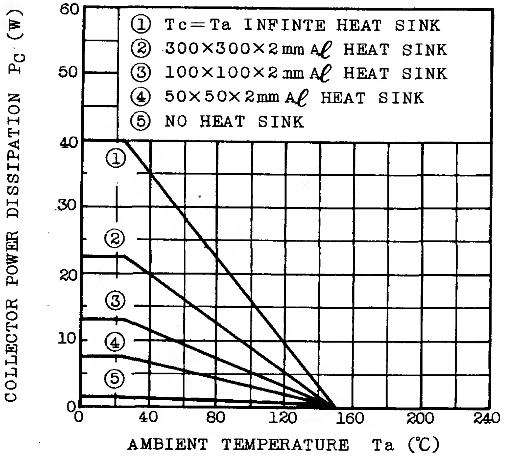
$V_{BE(sat)}$ – I_C



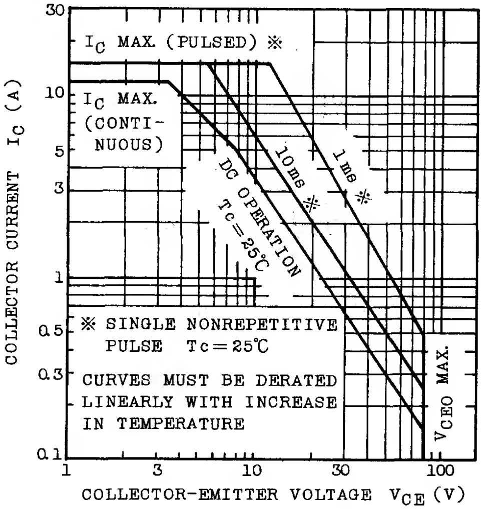
I_C – V_{BE}



P_C – Ta



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

2SC3376

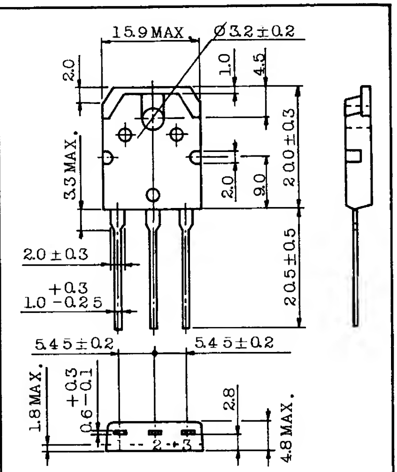
SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

. Excellent Switching Times (I_C=0.8A)
  : t_r=1.0μs (Max.), t_f=1.0μs (Max.)

. High Collector-Emitter Breakdown Voltage : V_{CEO}=800V

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

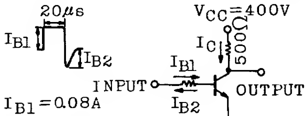
JEDEC	—
EIAJ	—
TOSHIBA	2-16C1A

Weight : 4.6g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	3	A
	Pulse	I_{CP}	5	
Base Current		I_B	1	A
Collector Power Dissipation (T_c=25°C)		P_C	60	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	-	-	V
Collector-Emitter Breakdwon Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	800	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.8A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=0.8A, I_B=0.16A	-	-	0.6	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=0.8A, I_B=0.16A	-	-	1.2	V
Switching Time	Rise Time	t_r	 20μs VCC=400V IB1 IB2 IC 500Ω IB1 INPUT IB2 OUTPUT I_{B1}=0.08A I_{B2}=−0.20A DUTY CYCLE≦1%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

2SD
SERIES

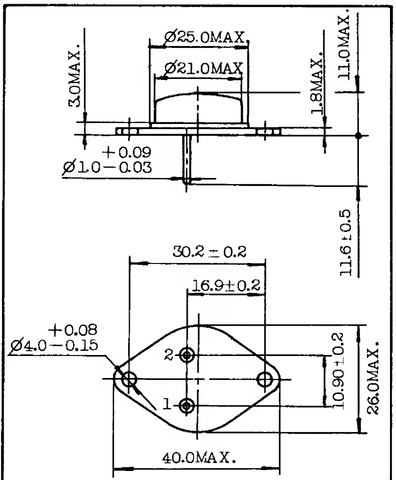
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD523

HIGH POWER SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting Kit No. AC73
Weight : 12g

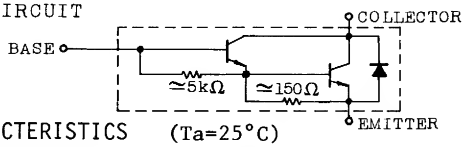
FEATURES:

- High DC Current Gain
  : h_{FE}=2000 (Min.) (V_{CE}=3V, I_C=3A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V (Max.) (I_C=3A)
- Monolithic Consturction With Built-In Base-Emitter Shunt Resistor.

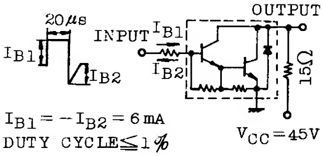
MAXIMUM RATINGS (Ta=25°C)

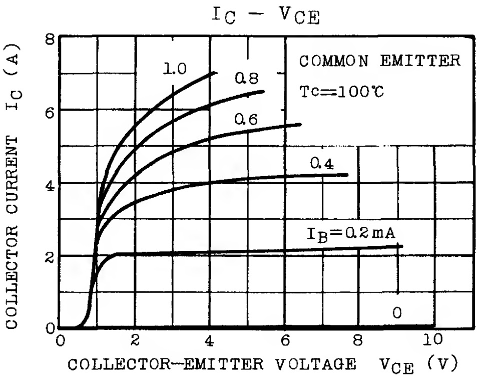
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	0.2	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−65∼150	°C

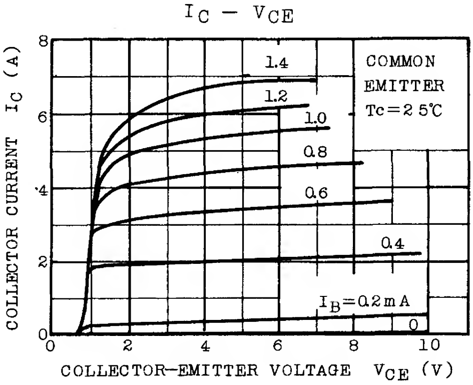
EQUIVALENT CIRCUIT

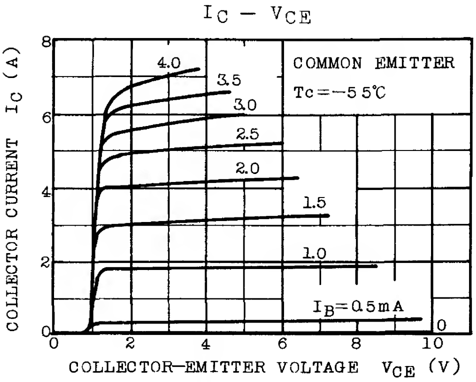


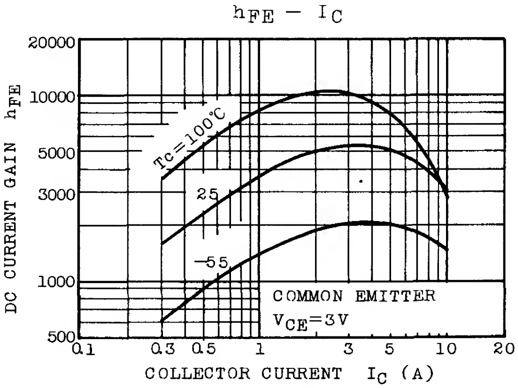
ELECTRICAL CHARACTERISTICS (Ta=25°C)

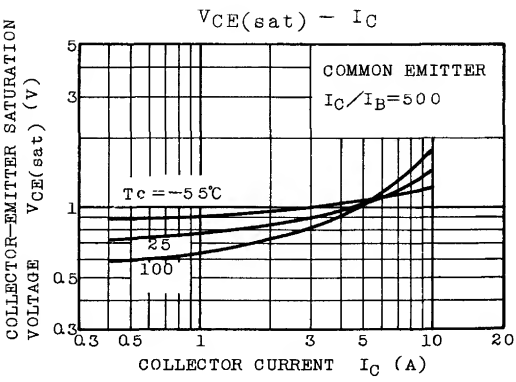
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	−	−	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=3V, I_C=3A	2000	−	15000	
		$h_{FE(2)}$	V_{CE}=3V, I_C=7A	1000	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)1}$	I_C=3A, I_B=6mA	−	0.9	1.5	V
		$V_{CE(sat)2}$	I_C=7A, I_B=14mA	−	1.2	2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=6mA	−	1.5	2.5	V
Switching Time	Turn-On Time	t_{on}	 $I_{B1}=-I_{B2}=6$ mA DUTY CYCLE≦1%	−	0.8	−	μs
	Storage Time	t_{stg}		−	3.0	−	
	Fall Time	t_f		−	2.5	−	

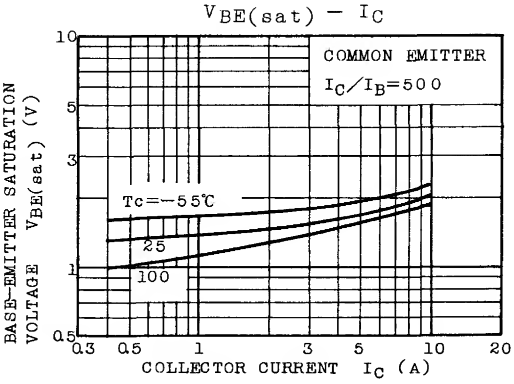

IC − VCE
COMMON EMITTER
Tc=100℃
1.0
0.8
0.6
0.4
IB=0.2mA
0
COLLECTOR CURRENT IC (A)
8
6
4
2
0
0
2
4
6
8
10
COLLECTOR−EMITTER VOLTAGE VCE (V)

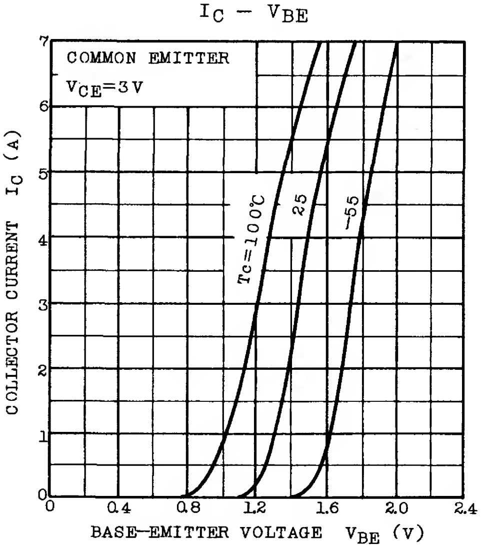

IC − VCE
COMMON EMITTER
Tc=25℃
1.4
1.2
1.0
0.8
0.6
0.4
IB=0.2mA
0
COLLECTOR CURRENT IC (A)
8
6
4
2
0
0
2
4
6
8
10
COLLECTOR−EMITTER VOLTAGE VCE (V)

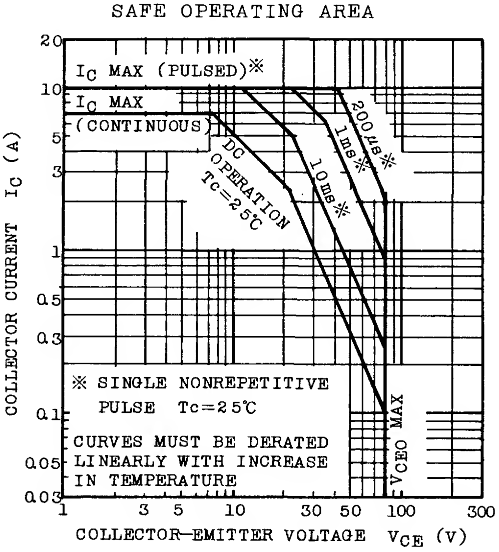

IC − VCE
COMMON EMITTER
Tc=−55℃
4.0
3.5
3.0
2.5
2.0
1.5
1.0
IB=0.5mA
0
COLLECTOR CURRENT IC (A)
8
6
4
2
0
0
2
4
6
8
10
COLLECTOR−EMITTER VOLTAGE VCE (V)


hFE − IC
Tc=100℃
25
−55
COMMON EMITTER
VCE=3V
DC CURRENT GAIN hFE
20000
10000
5000
3000
1000
500
0.1
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC/IB=500
Tc=−55℃
25
100
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
5
3
1
0.5
0.3
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


VBE(sat) − IC
COMMON EMITTER
IC/IB=500
Tc=−55℃
25
100
BASE−EMITTER SATURATION VOLTAGE VBE(sat) (V)
10
5
3
1
0.5
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


IC − VBE
COMMON EMITTER
VCE=3V
Tc=100°C
25
−55
COLLECTOR CURRENT IC (A)
0
1
2
3
4
5
6
7
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE−EMITTER VOLTAGE VBE (V)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX
(CONTINUOUS)
DC OPERATION Tc=25°C
10ms※
1ms※
200μs※
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.03
1
3
5
10
30
50
100
300
COLLECTOR−EMITTER VOLTAGE VCE (V)

2SD524

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

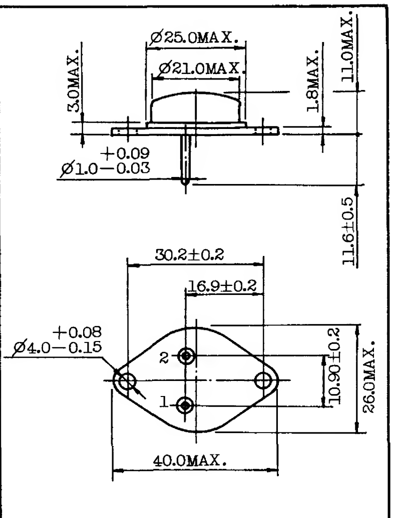
INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000 (Min.) (V_{CE}=3V, I_C=5A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V (Max.) (I_C=5A)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO — 3
EIAJ	TC — 3, TB — 3
TOSHIBA	2 — 21A1A

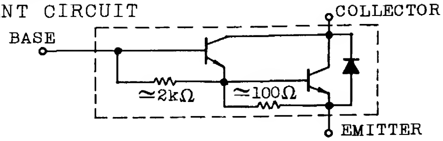
Mounting Kit No. AC73

Weight : 12.9g

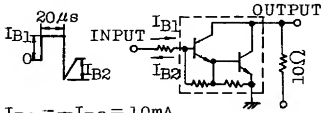
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	0.2	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

EQUIVALENT CIRCUIT

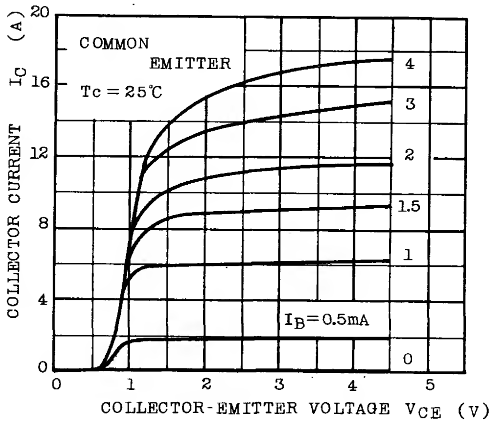


ELECTRICAL CHARACTERISTICS (Ta=25°C)

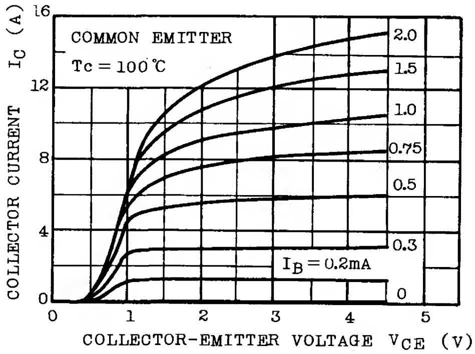
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=3V, I_C=5A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=3V, I_C=15A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	I_C=5A, I_B=10mA	-	-	1.5	V
		$V_{CE(sat)(2)}$	I_C=15A, I_B=30mA	-	-	2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=10mA	-	-	2.5	V
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} 0 I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω I_{B1}=−I_{B2}=10mA DUTY CYCLE≦1% V_{CC}=50V	-	0.8	-	μs
	Storage Time	t_{stg}		-	4.0	-	
	Fall Time	t_f		-	3.0	-	

TOSHIBA CORPORATION

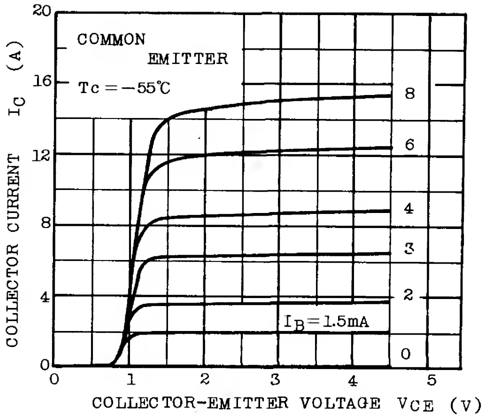
I_C - V_{CE}



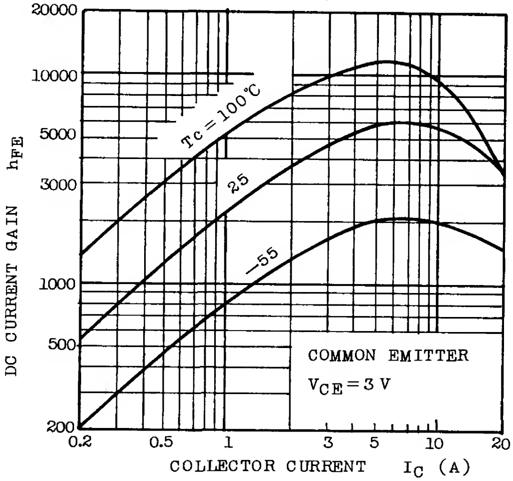
I_C - V_{CE}



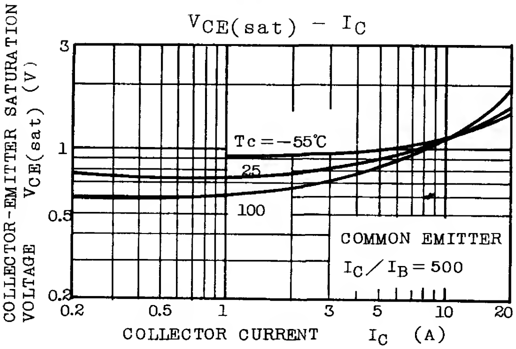
I_C - V_{CE}



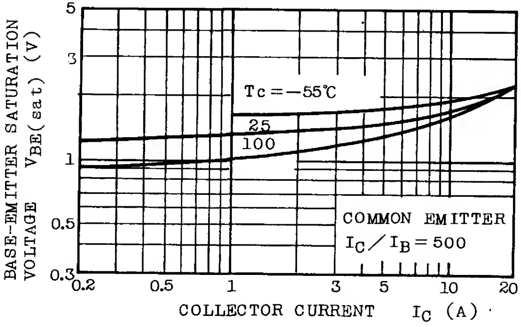
h_{FE} - I_C



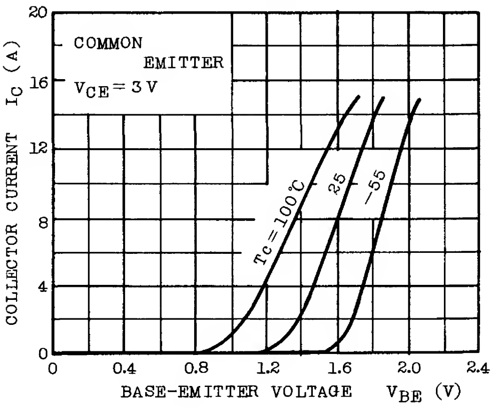
$V_{CE(sat)}$ - I_C



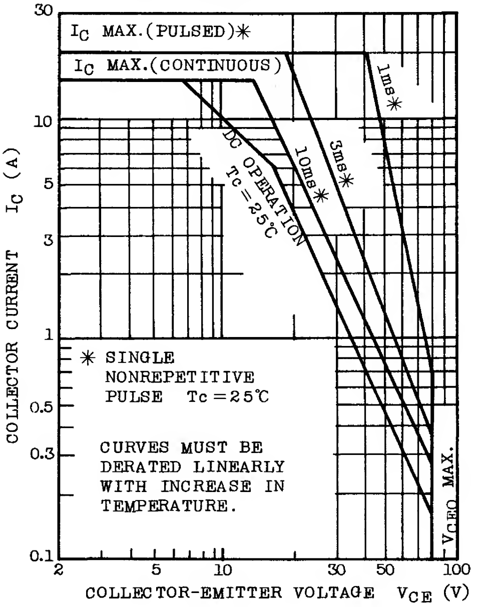
$V_{BE(sat)}$ - I_C



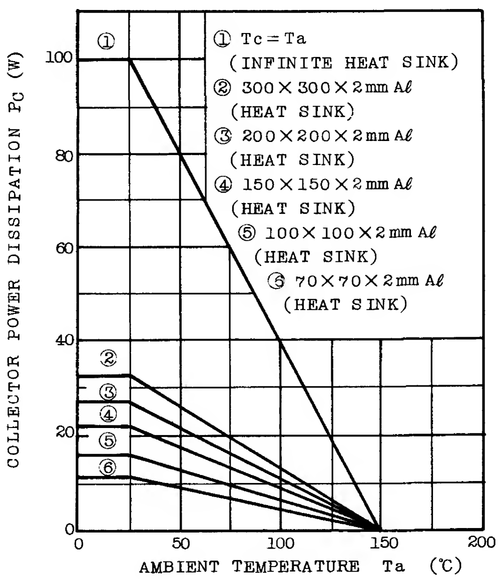
I_C – V_{BE}



SAFE OPERATING AREA



P_C – Ta



SILICON NPN TRIPLE DIFFUSED TYPE

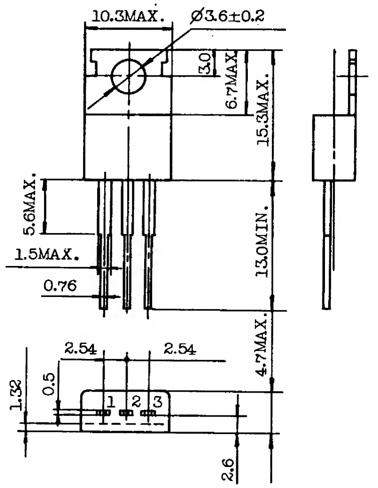
2SD525

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=100V
- Low Collector Saturation Voltage : $V_{CE(sat)}$=2.0V(Max.)
- Complementary to 2SB595.
- Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

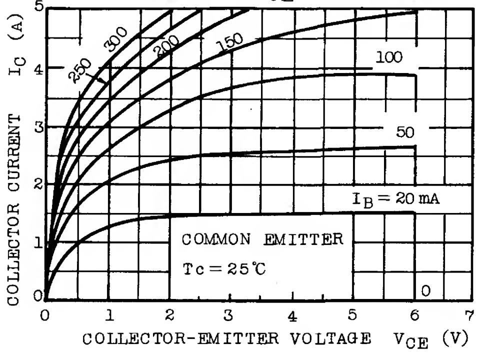
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Base Current	I_B	4	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

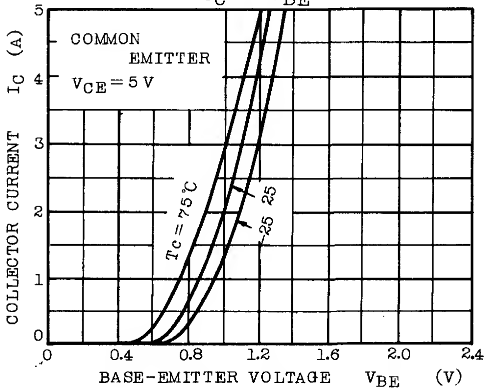
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=1A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	12	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40∿80, O : 70∿140, Y : 120∿240

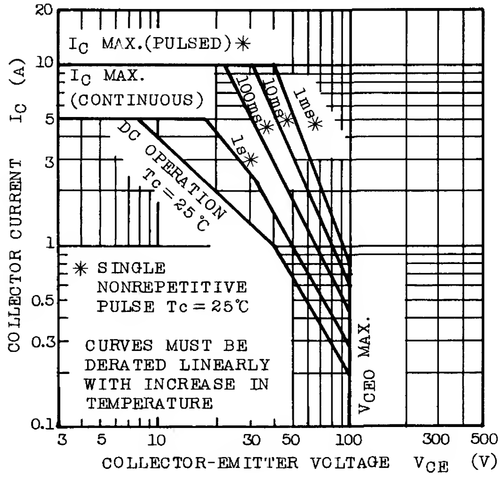
I_C – V_{CE}



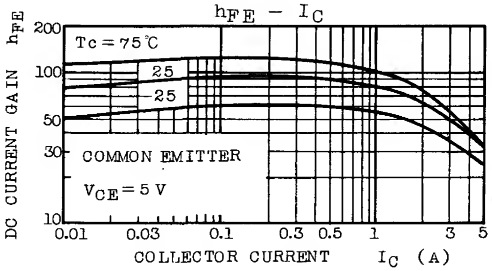
I_C – V_{BE}



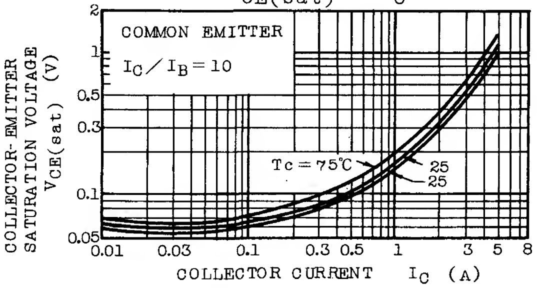
SAFE OPERATING AREA



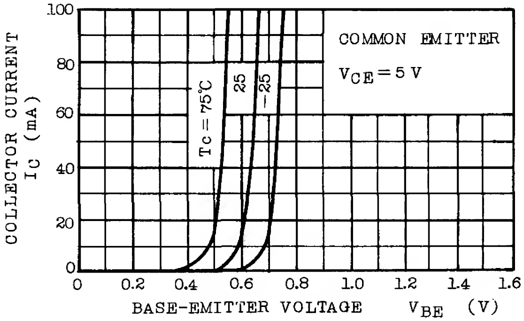
h_{FE} – I_C



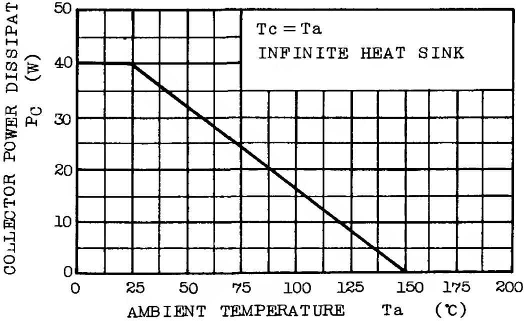
$V_{CE(sat)}$ – I_C



I_C – V_{BE}



P_C – Ta



SILICON NPN TRIPLE DIFFUSED TYPE

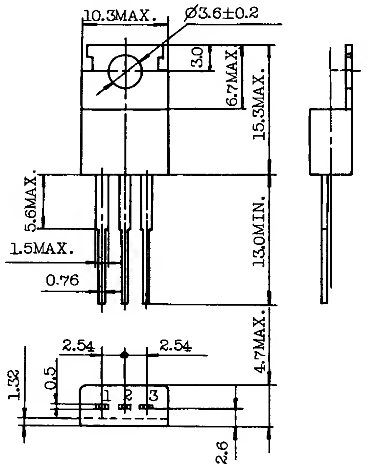
2SD526

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=30W (Tc=25°C)
- Good Linearity of h_{FE}.
- Complementary to 2SB596.
- Recommended for 20 ∿ 25W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10 A 1 A

Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

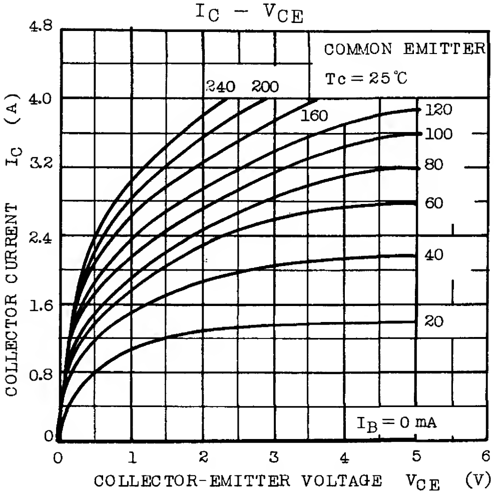
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

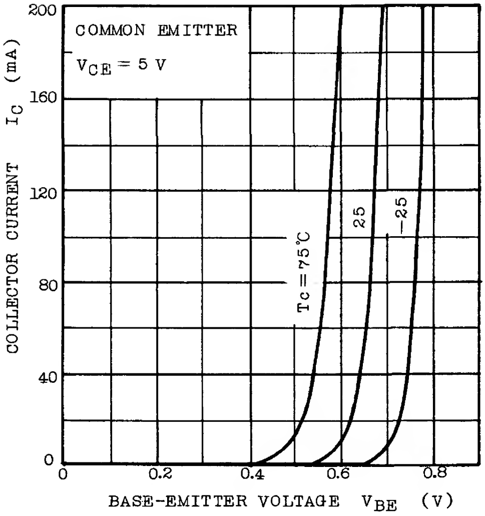
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=80V, I_E=0	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=3A	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=3A	-	1.0	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	3	8.0	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40∿80, O : 70∿140, Y : 120∿240

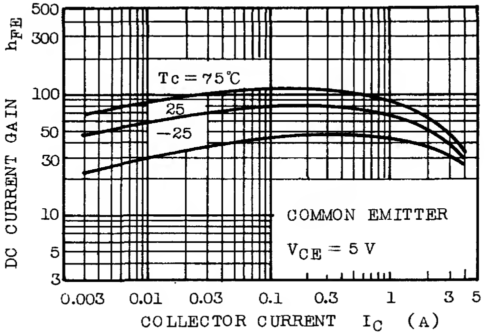
$I_C - V_{CE}$



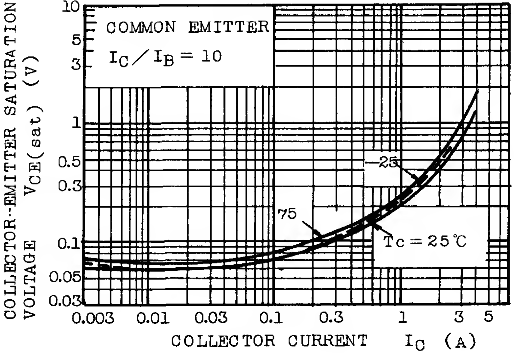
$I_C - V_{BE}$



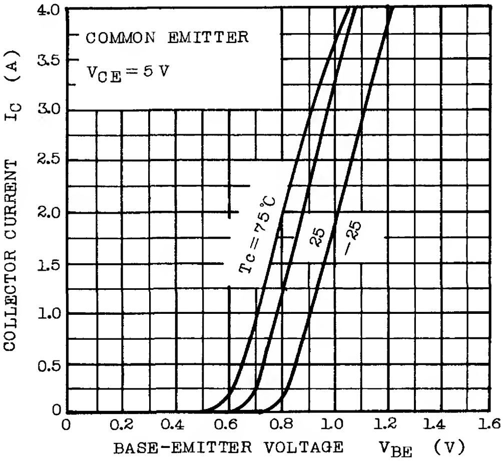
$h_{FE} - I_C$

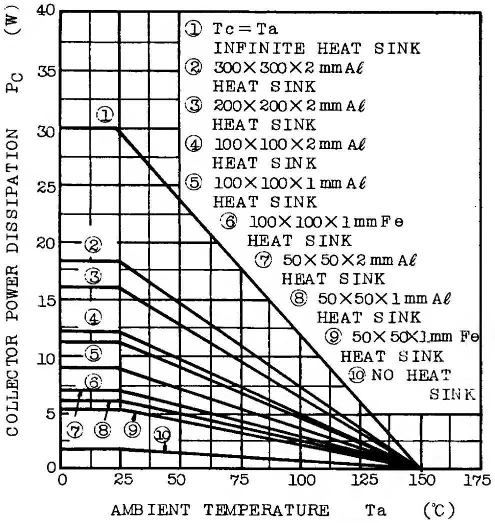


$V_{CE(sat)} - I_C$

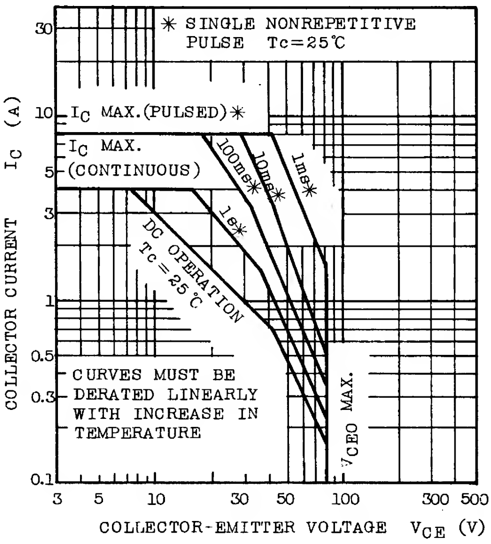


$I_C - V_{BE}$





P_C − Ta



SAFE OPERATING AREA

2SD548

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

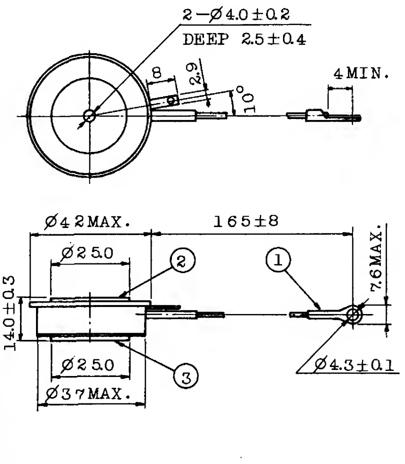
INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- High Voltage : $V_{CEO(SUS)}$=450V
- Triple Diffused Design.
- Darlington Design

Unit in mm



1. BASE
2. EMITTER
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−42A1A

Weight : 70g

MAXIMUM RATINGS (T_a=25°C)

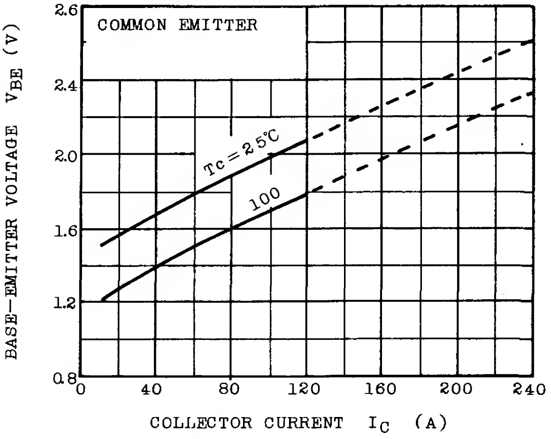
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	120	A
Emitter Current	I_E	-120	A
Base Current	I_B	8	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.13	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	-40~150	°C
Mounting Force Required	F	400±40	kg

ELECTRICAL CHARACTERISTICS (T_a=25°C)

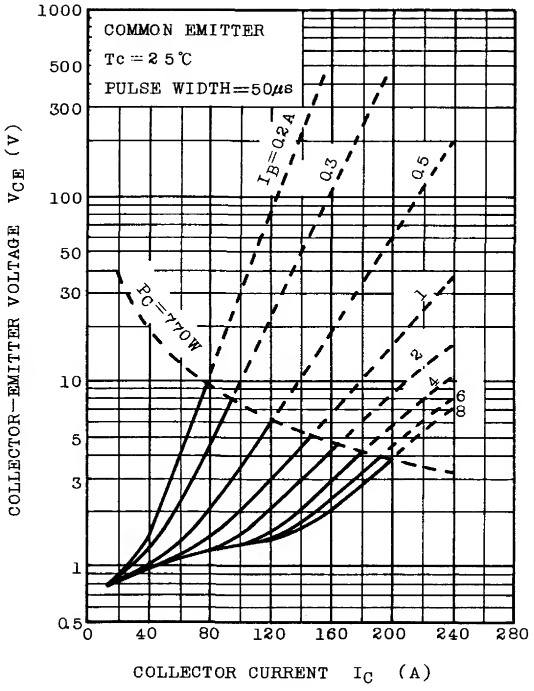
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=120A	150	-	-	
			V_{CE}=5V, I_C=60A	-	500	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=120A, I_B=2.4A (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	2	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	150	mA
Switching Time	Turn-on Time	t_{on}	I_C=120A, I_{B1}=2.4A, $-I_{B2}$=2.4A, V_C=300V	-	3	-	μs
	Storage Time	t_{stg}		-	12	-	μs
	Fall Time	t_f		-	8	-	μs

Note : Pulse Test; Pulse Width≦300μs , Duty Cycle≦3%
Mounting Force; F=400kg

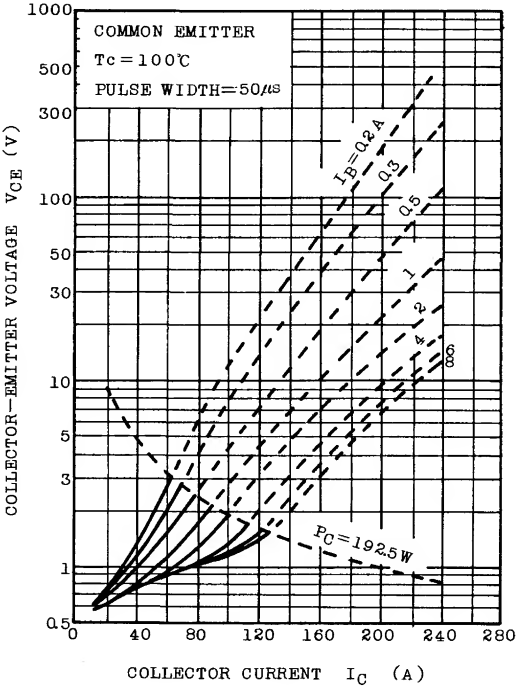
$V_{BE(sat)} - I_C$



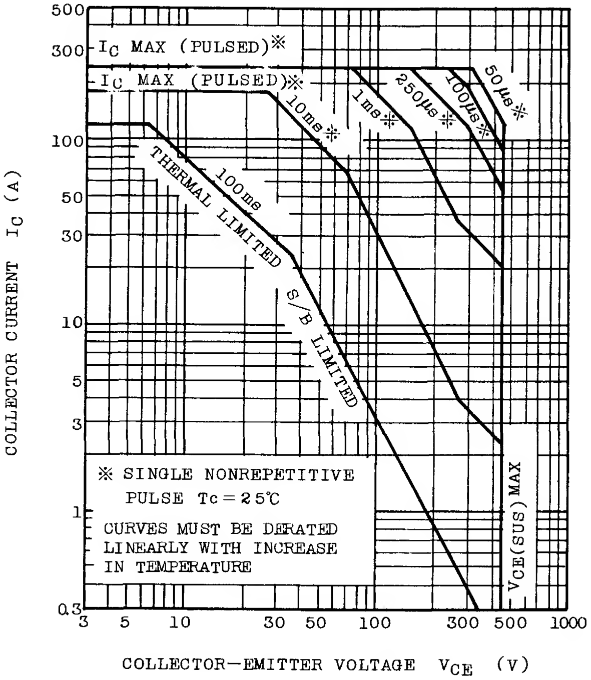
$V_{CE} - I_C$



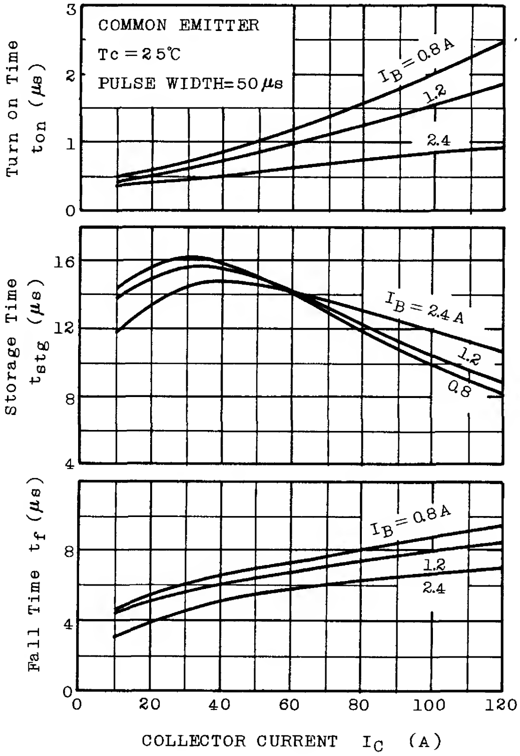
$V_{CE} - I_C$



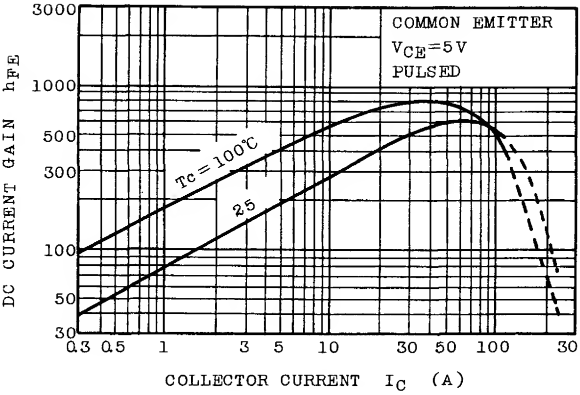
SAFE OPERATING AREA



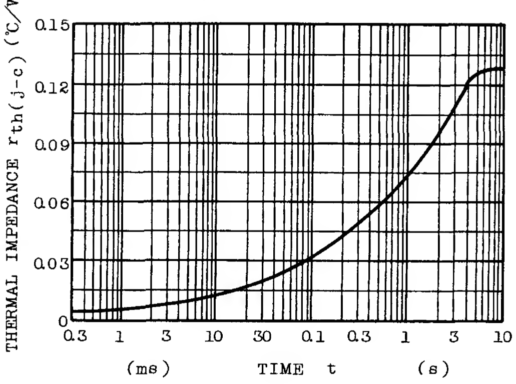
SWITCHING CHARACTERISTICS



h_{FE} – I_C



TRANSIENT THERMAL IMPEDANCE
(JUNCTION - CASE)



SILICON NPN EPITAXIAL TYPE
(DARLINGTON POWER)

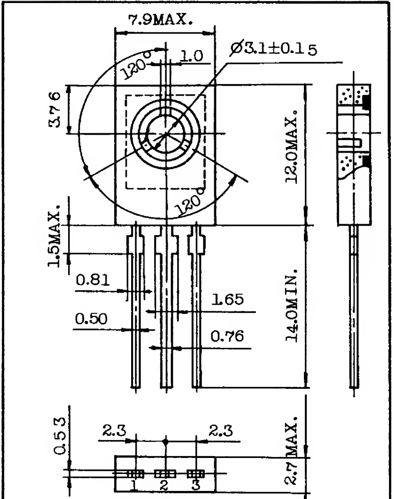
2SD549

PULSE MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=4000(Min.) (V_{CE}=2V, I_C=150mA)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=1A, I_B=1mA)

Unit in mm



1. EMITTER
2. COLLECTOR(HEAT SINK)
3. BASE

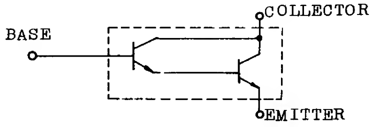
JEDEC	TO — 126
EIAJ	—
TOSHIBA	2 — 8F1A

Mounting Kit No. AC46C
Weight : 0.72g

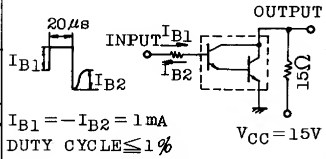
MAXIMUM RATINGS (Ta=25°C)

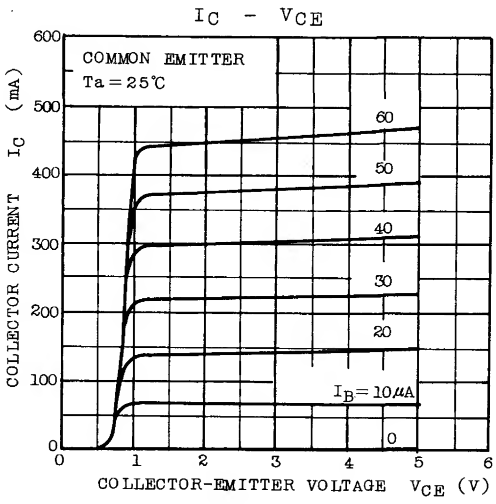
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Base Voltage	V_{EBO}	10	V
Continuous Collector Current	I_C	1.5	A
Collector Power Dissipation (Ta=25°C)	P_C	1.0	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

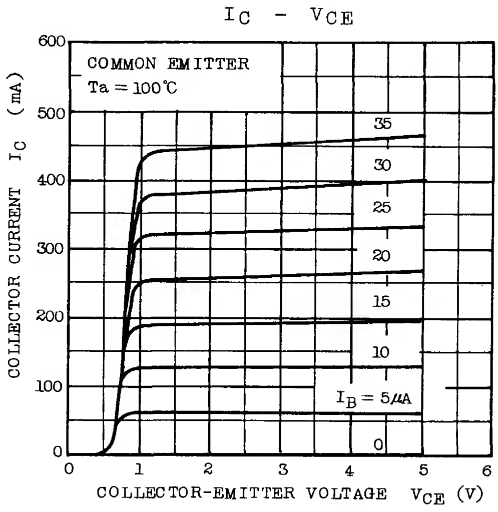
EQUIVALENT CIRCUIT

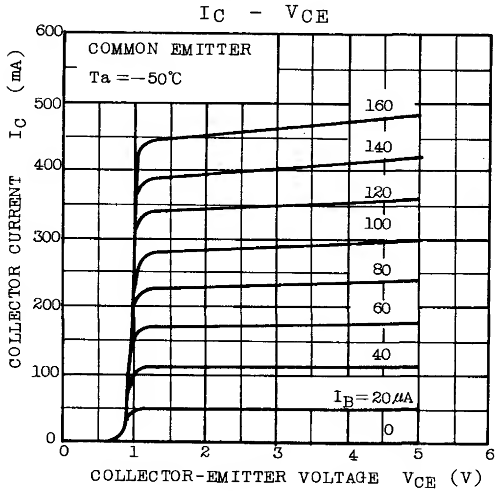


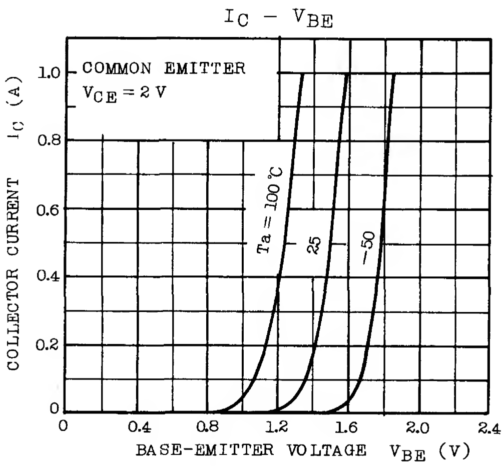
ELECTRICAL CHARACTERISTICS (Ta=25°C)

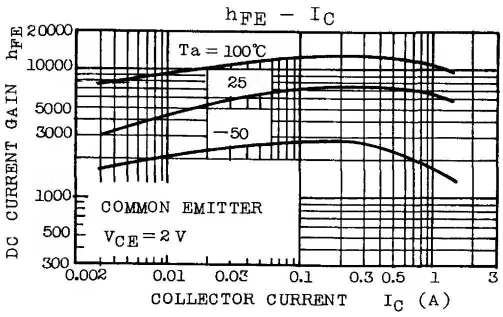
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=10V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	30	-	-	V
DC Current Gain		h_{FE}	V_{CE}=2V, I_C=150mA	4000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=1mA	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=1mA	-	-	2.2	V
Switching Time	Turn-on Time	t_{on}	 20μs OUTPUT INPUT I_{B1} I_{B1} I_{B2} I_{B2} 15Ω I_{B1}=−I_{B2}=1mA DUTY CYCLE≦1% V_{CC}=15V	-	0.18	-	μs
	Storage Time	t_{stg}		-	0.6	-	
	Fall Time	t_f		-	0.3	-	

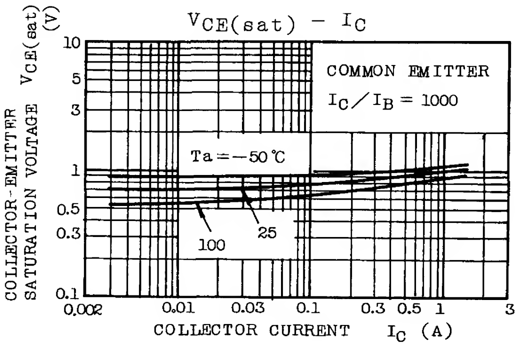

IC – VCE
COMMON EMITTER
Ta = 25°C
60
50
40
30
20
IB = 10μA
0
COLLECTOR CURRENT IC (mA)
0
100
200
300
400
500
600
0
1
2
3
4
5
6
COLLECTOR-EMITTER VOLTAGE VCE (V)


IC – VCE
COMMON EMITTER
Ta = 100°C
35
30
25
20
15
10
IB = 5μA
0
COLLECTOR CURRENT IC (mA)
0
100
200
300
400
500
600
0
1
2
3
4
5
6
COLLECTOR-EMITTER VOLTAGE VCE (V)

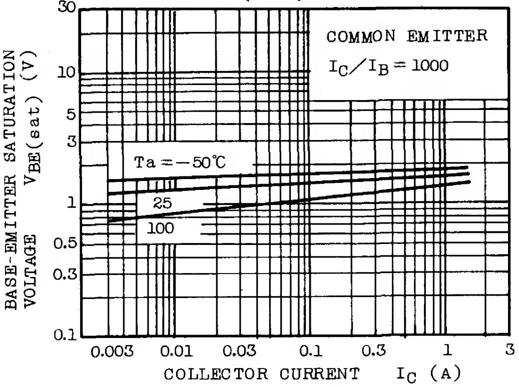

IC – VCE
COMMON EMITTER
Ta = −50°C
160
140
120
100
80
60
40
IB = 20μA
0
COLLECTOR CURRENT IC (mA)
0
100
200
300
400
500
600
0
1
2
3
4
5
6
COLLECTOR-EMITTER VOLTAGE VCE (V)


IC – VBE
COMMON EMITTER
VCE = 2 V
Ta = 100°C
25
−50
COLLECTOR CURRENT IC (A)
0
0.2
0.4
0.6
0.8
1.0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE-EMITTER VOLTAGE VBE (V)

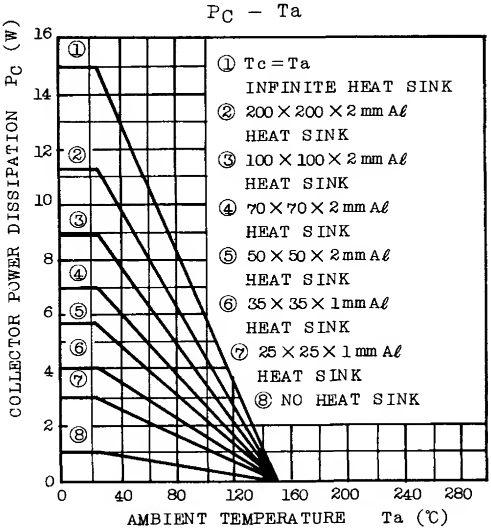

hFE – IC
Ta = 100°C
25
−50
COMMON EMITTER
VCE = 2 V
DC CURRENT GAIN hFE
20000
10000
5000
3000
1000
500
300
0.002
0.01
0.03
0.1
0.3
0.5
1
3
COLLECTOR CURRENT IC (A)


VCE(sat) – IC
COMMON EMITTER
IC/IB = 1000
Ta = −50°C
100
25
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
10
5
3
1
0.5
0.3
0.1
0.002
0.01
0.03
0.1
0.3
0.5
1
3
COLLECTOR CURRENT IC (A)

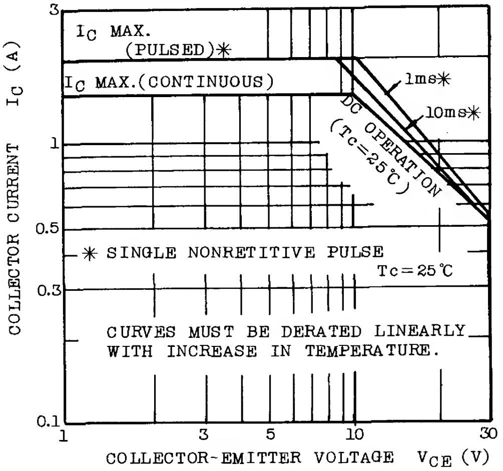
$V_{BE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



2SD552

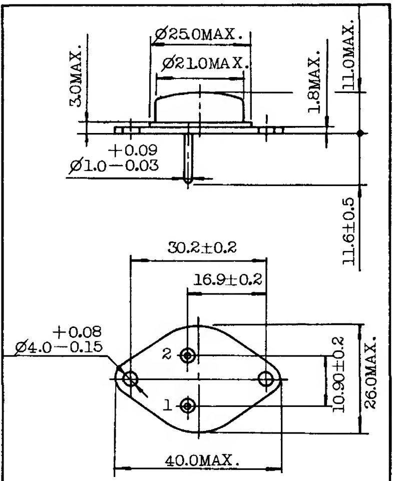
SILICON NPN TRIPLE DIFFUSED TYPE

HGIH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=150W (Tc=25°C)
- High Collector Current : I_C=15A
- High Voltage : V_{CEO}=180V
- Complementary to 2SB552.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

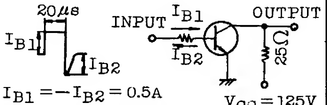
JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting Kit No. AC73
Weight : 12.9g

MAXIMUM RATINGS (Ta=25°C)

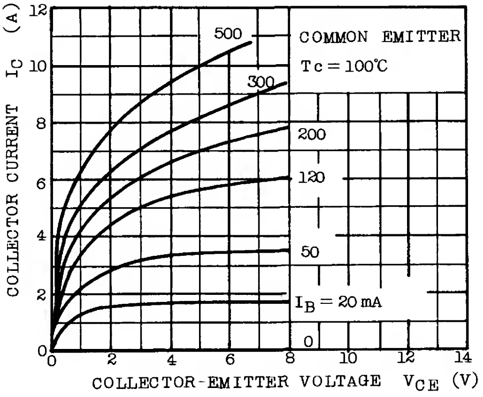
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	220	V
Collector-Emitter Voltage	V_{CEO}	180	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

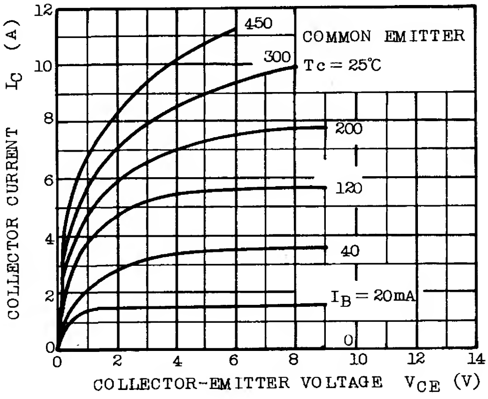
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=150V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	180	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=5A	25	-	80	
		$h_{FE(2)}$	V_{CE}=5V, I_C=15A	10	15	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=1A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	1.5	2.5	V
Transition Frequency		f_T	V_{CE}=10V, I_C=1A	-	4	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	160	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	3.5	-	
	Fall Time	t_f	I_{B1} = $-I_{B2}$ = 0.5A DUTY CYCLE≦1%	-	0.5	-	

Note : $h_{FE(1)}$ Classification BN : 25∿50, R : 40∿80

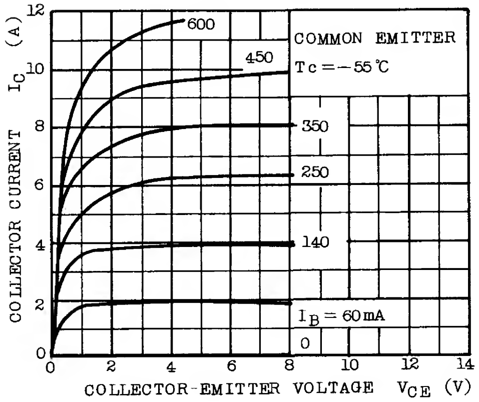
I_C – V_{CE}



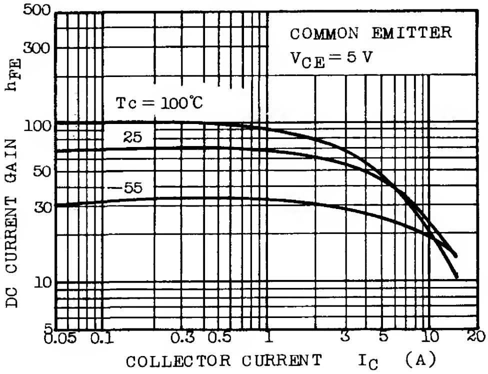
I_C – V_{CE}



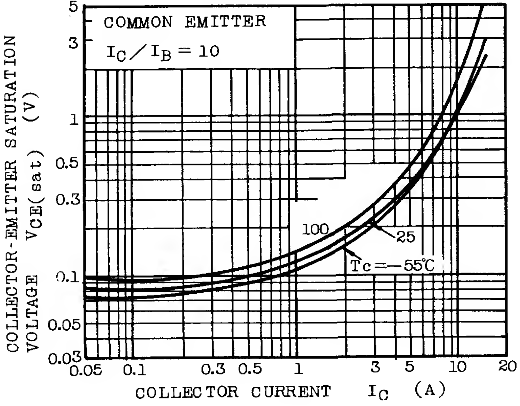
I_C – V_{CE}



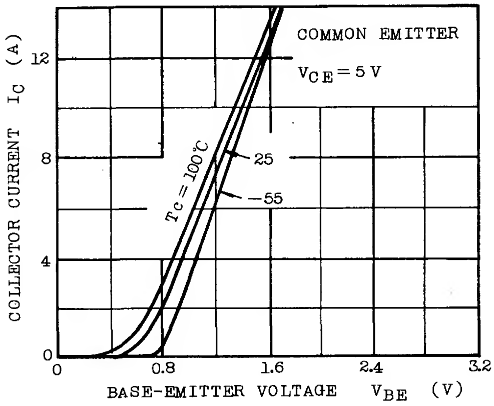
h_{FE} – I_C

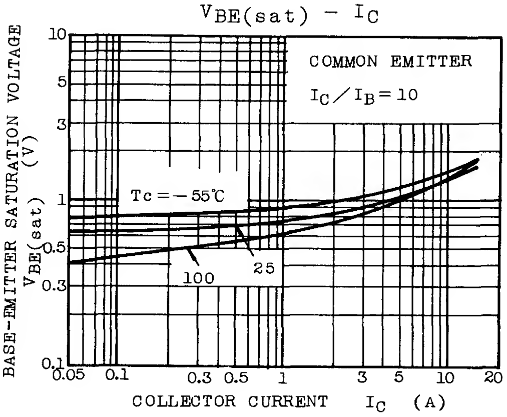


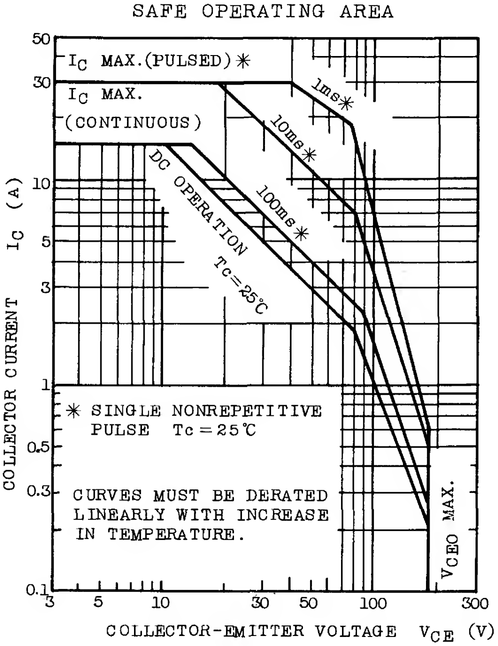
$V_{CE(sat)}$ – I_C



I_C – V_{BE}




VBE(sat) – IC
COMMON EMITTER
IC／IB＝10
Tc＝－55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
10
5
3
1
0.5
0.3
0.1
0.05
0.1
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
IC MAX.(PULSED)＊
IC MAX.
(CONTINUOUS)
1ms＊
10ms＊
100ms＊
DC OPERATION
Tc＝25℃
＊ SINGLE NONREPETITIVE PULSE Tc＝25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.
COLLECTOR CURRENT IC (A)
50
30
10
5
3
1
0.5
0.3
0.1
3
5
10
30
50
100
300
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE

2SD553

INDUSTRIAL APPLICATIONS

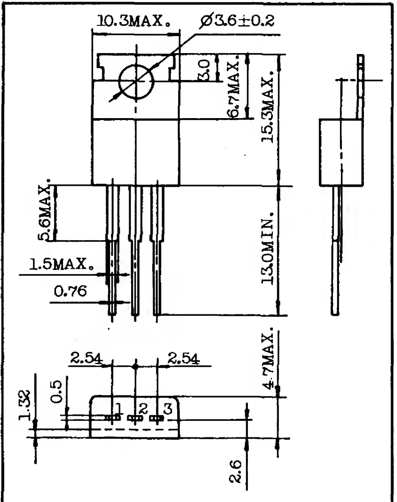
HIGH CURRENT SWITCHING APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
  : $V_{CE(sat)}=0.4V$ (Max.) (at $I_C=4A$)
- Complementary to 2SB553.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

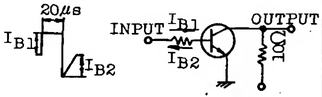
Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

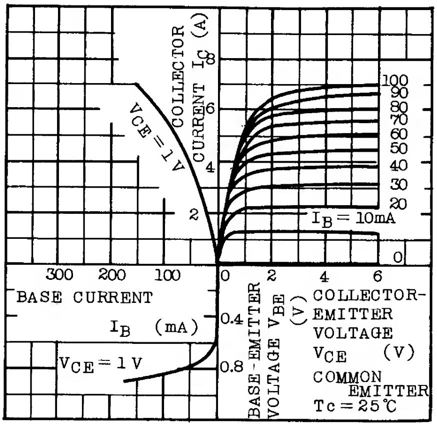
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	70	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

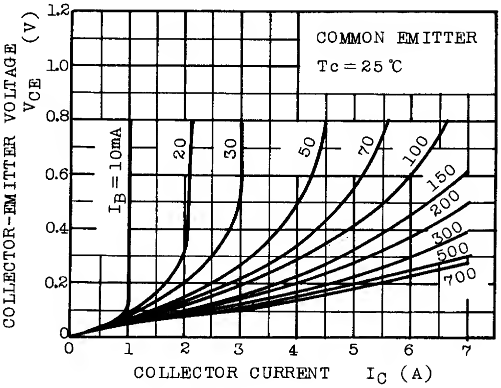
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=70V$, $I_E=0$	–	–	30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	–	–	50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	50	–	–	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V$, $I_C=1A$	70	–	240	
		$h_{FE(2)}$	$V_{CE}=1V$, $I_C=4A$	30	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=4A$, $I_B=0.4A$	–	0.2	0.4	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=4A$, $I_B=0.4A$	–	0.9	1.2	V
Transition Frequency		f_T	$V_{CE}=4V$, $I_C=1A$	–	10	–	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	–	250	–	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω $V_{CC}=30V$ $I_{B1}=-I_{B2}=0.3A$ DUTY CYCLE≦1%	–	0.2	–	μs
	Storage Time	t_{stg}		–	2.5	–	
	Fall Time	t_f		–	0.5	–	

Note: $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

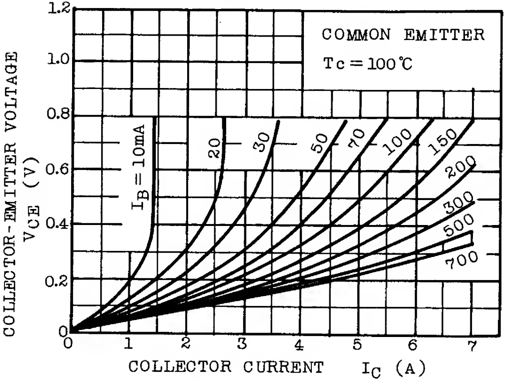
STATIC CHARACTERISTICS



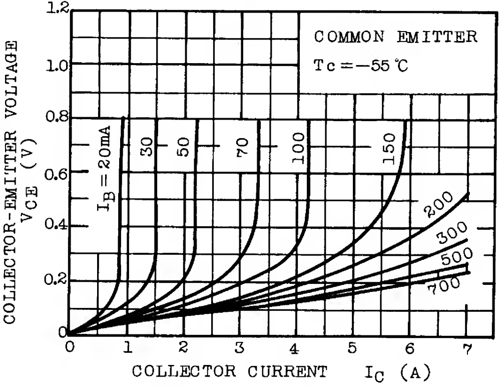
V_{CE} – I_C



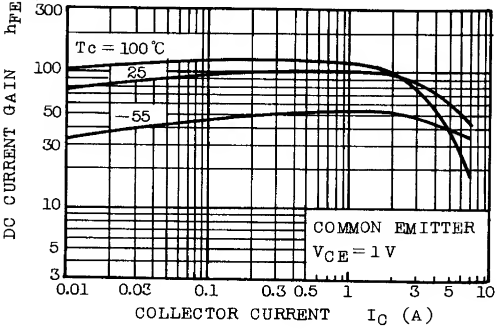
V_{CE} – I_C



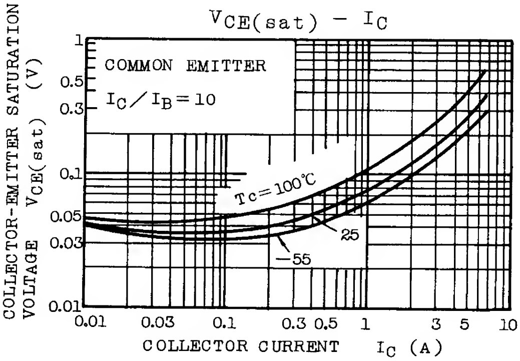
V_{CE} – I_C



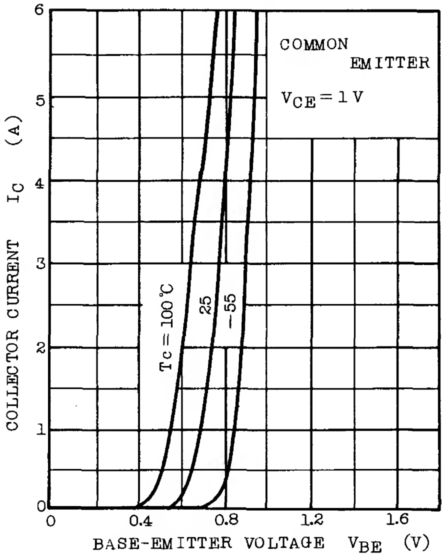
h_{FE} – I_C



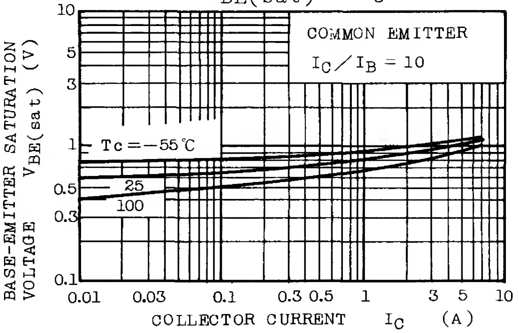
$V_{CE(sat)}$ – I_C



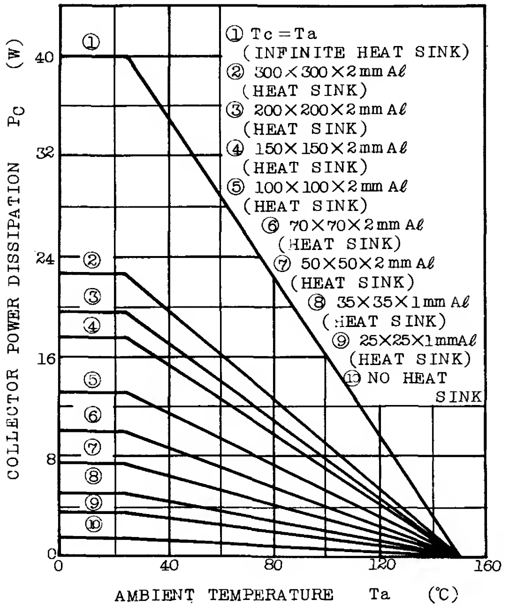
$I_C - V_{BE}$



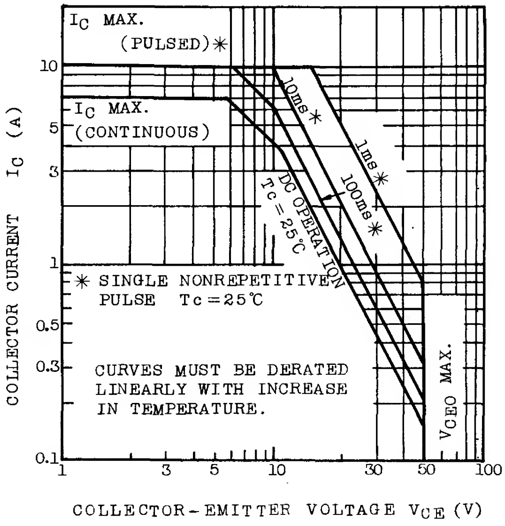
$V_{BE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



2SD633
2SD634
2SD635

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

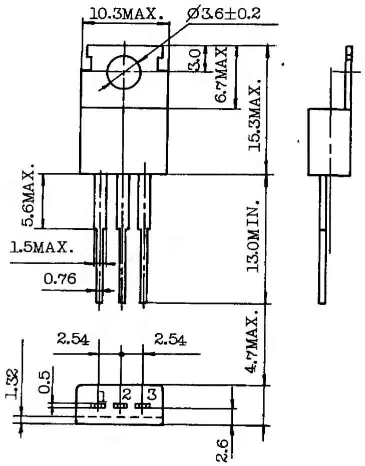
HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain
  : $h_{FE}=2000$ (Min.) ($V_{CE}=3V$, $I_C=3A$)
- Low Saturation Voltage
  : $V_{CE(sat)}=1.5V$ (Max.), ($I_C=3A$)
- Complementary to 2SB673, 2SB674, and 2SB675.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

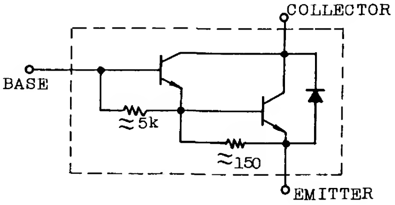
JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10 A 1 A

Mounting Kit No. AC75
Weight : 1.9g

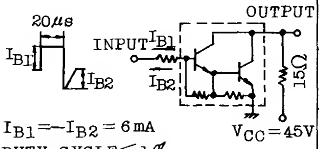
MAXIMUM RATINGS

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD633	V_{CBO}	100	V
	2SD634		80	
	2SD635		60	
Collector-Emitter Voltage	2SD633	V_{CEO}	100	V
	2SD634		80	
	2SD635		60	
Emitter-Base Voltage		V_{EBO}	5	V
Continuous Collector Current		I_C	7	A
Contunuous Base Current		I_B	0.2	A
Collector Power Dissipation (Tc=25°C)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

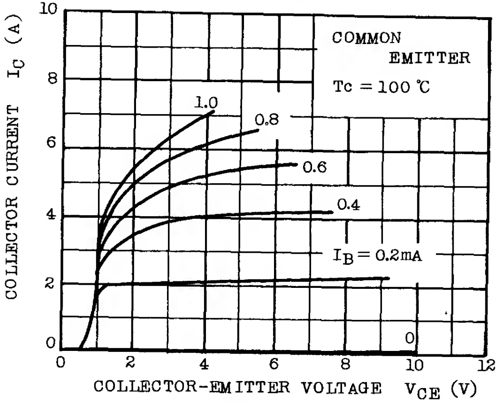
EQUIVALENT CIRCUIT



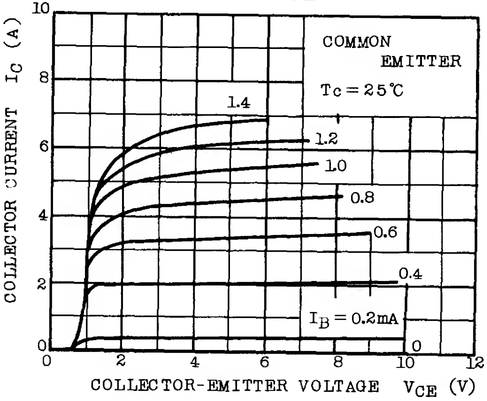
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SD633	I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
	2SD634		V_{CB}=80V, I_E=0	-	-	100	
	2SD635		V_{CB}=60V, I_E=0	-	-	100	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	3.0	mA
Collector-Emitter Breakdown Voltage	2SD633	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
	2SD634			80	-	-	
	2SD635			60	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=3V, I_C=3A	2000	-	15000	
		$h_{FE(2)}$	V_{CE}=3V, I_C=7A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	I_C=3A, I_B=6mA	-	0.9	1.5	V
		$V_{CE(sat)(2)}$	I_C=7A, I_B=14mA	-	1.2	2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=6mA	-	1.5	2.5	V
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 15Ω V_{CC}=45V I_{B1}=−I_{B2}=6mA DUTY CYCLE≦1%	-	0.8	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	2.5	-	

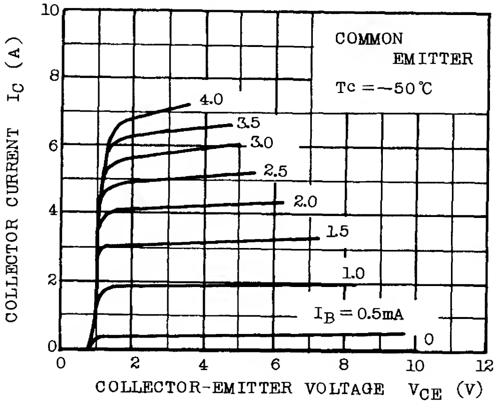
I_C – V_{CE}



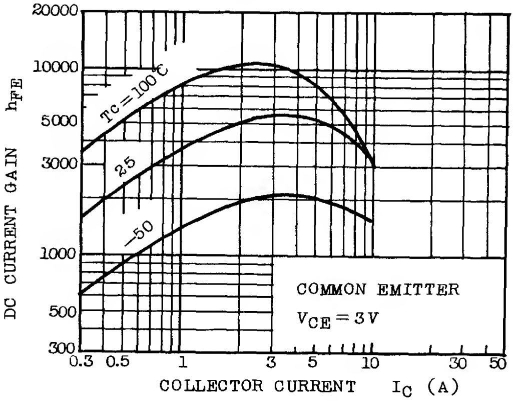
I_C – V_{CE}



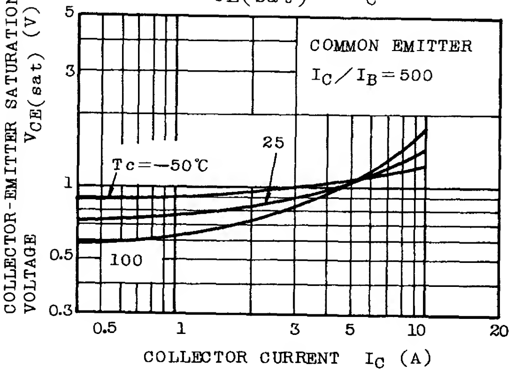
I_C – V_{CE}



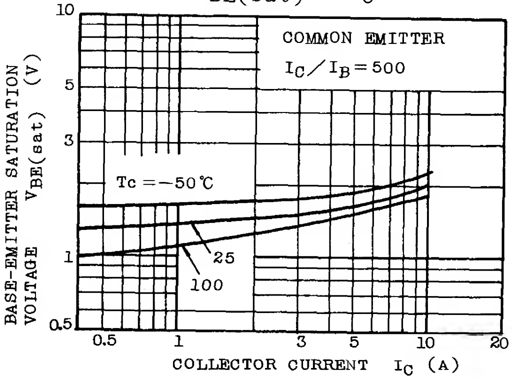
h_{FE} – I_C

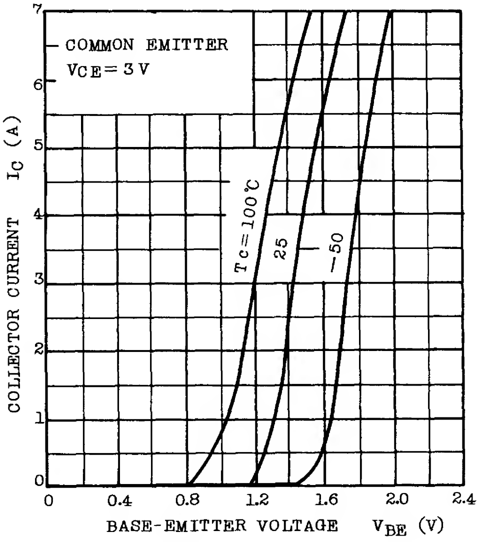


$V_{CE(sat)}$ – I_C

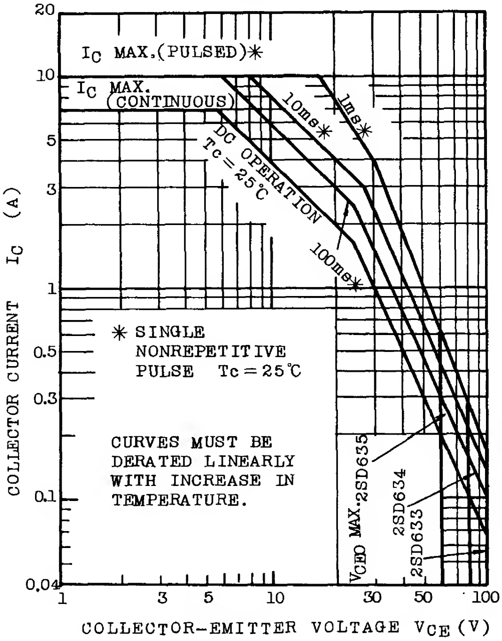


$V_{BE(sat)}$ – I_C





$I_C - V_{BE}$



SAFE OPERATING AREA

2SD640

SILICON NPN TRIPLE DIFFUSED TYPE

INDUSTRIAL APPLICATIONS

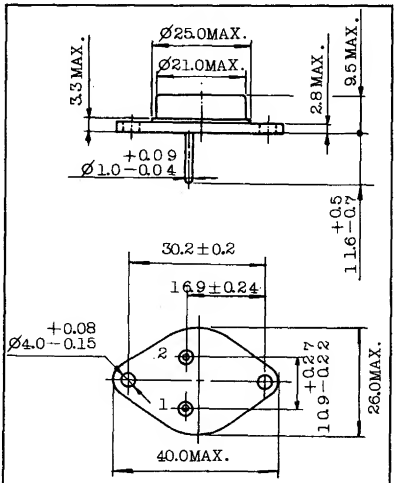
HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=400V
- Low Saturation Voltage : $V_{CE(sat)}$=1.5V (Max.)
  (I_C=5A, I_B=1A)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

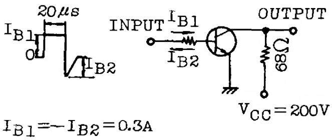
JEDEC	TO−204MA/TO−3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21E1A

Mounting Kit No.AC73
Weight : 15.8g

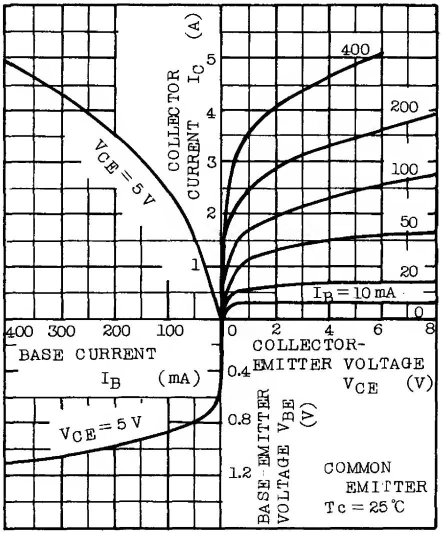
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

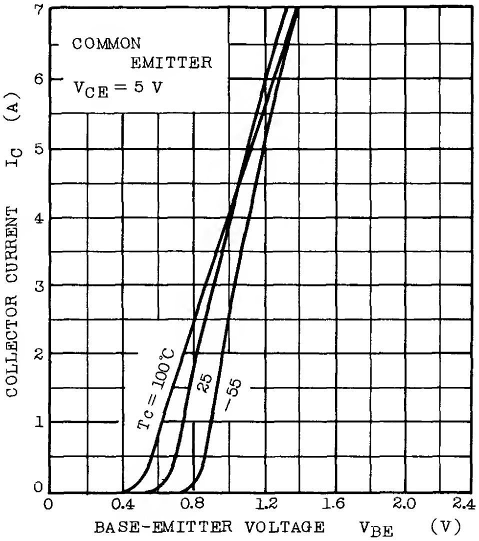
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=500V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=1A	25	-	140	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	2.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=0.5A	-	3	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=−I_{B2}=0.3A DUTY CYCLE ≦1%	-	1.0	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.6	-	

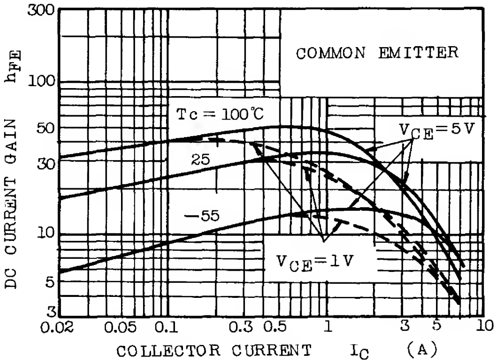
STATIC CHARACTERISTICS



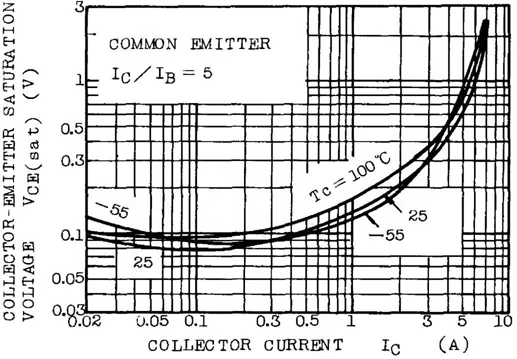
I_C – V_{BE}



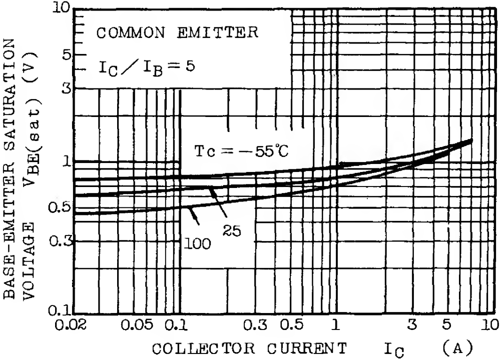
h_{FE} – I_C

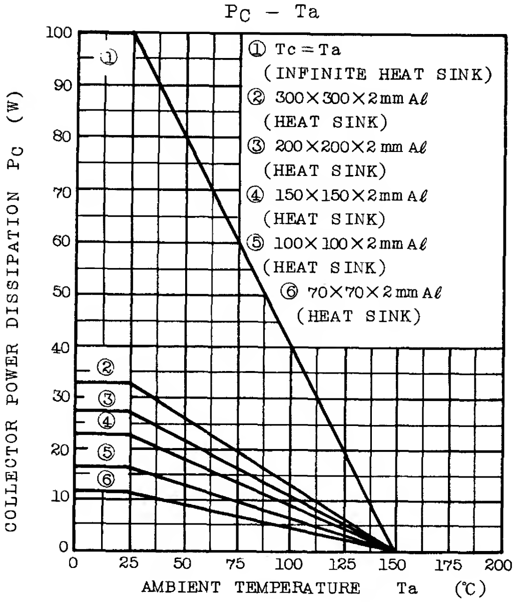


$V_{CE(sat)}$ – I_C

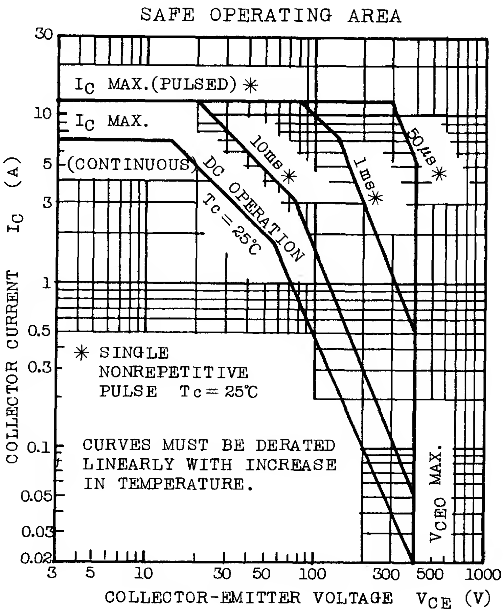


$V_{BE(sat)}$ – I_C





Pc – Ta



SAFE OPERATING AREA

SILICON NPN TRIPLE DIFFUSED TYPE

2SD641

INDUSTRIAL APPLICATIONS

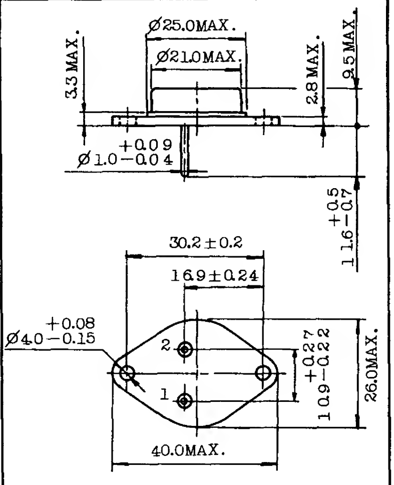
Unit in mm

HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Voltage : V_{CEO}=400V
- Low Saturation Voltage : $V_{CE(sat)}$=1.5V (Max.)
  (I_C=10A, I_B=2A)



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21E1A

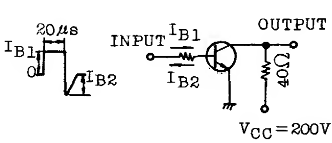
Mounting Kit No. AC73

Weight : 15.8g

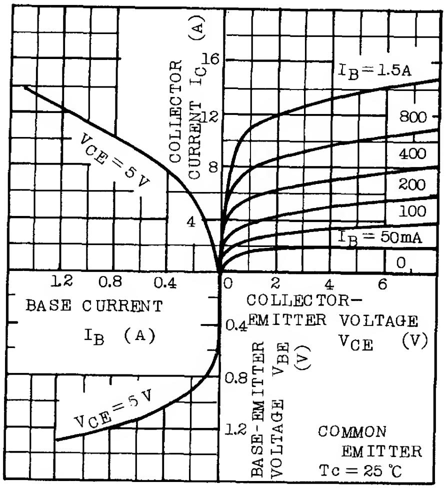
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	5	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

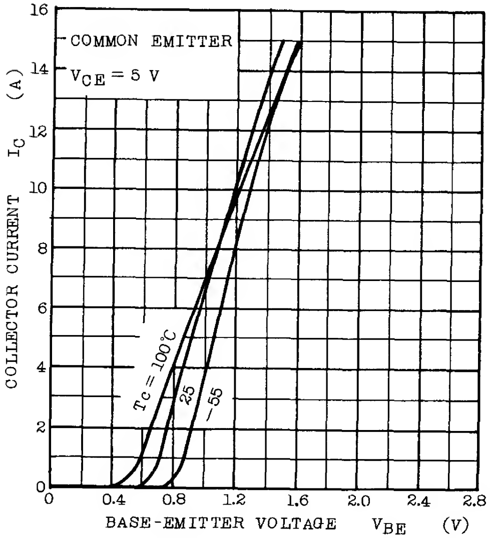
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=500V, I_E=0	−	−	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=20mA, I_B=0	400	−	−	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=5A	20	−	140	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=2A	−	−	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=2A	−	−	2.0	V
Transition Frequency		f_T	V_{CE}=10V, I_C=0.5A	−	4	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	−	150	−	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} 0 I_{B2} INPUT I_{B1} I_{B2} OUTPUT 40Ω V_{CC}=200V I_{B1}=−I_{B2}=0.5A DUTY CYCLE≦1%	−	0.8	−	μs
	Storage Time	t_{stg}		−	3.5	−	
	Fall Time	t_f		−	0.6	−	

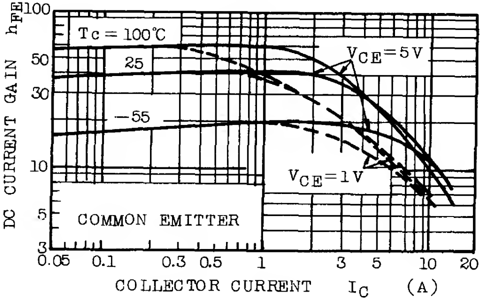
STATIC CHARACTERISTICS



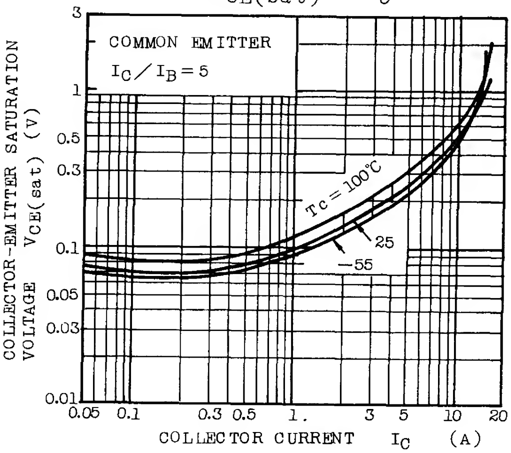
I_C – V_{BE}



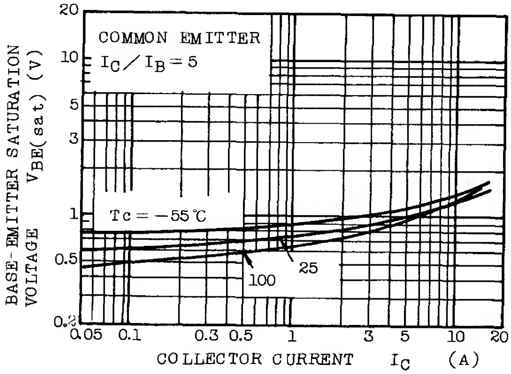
h_{FE} – I_C



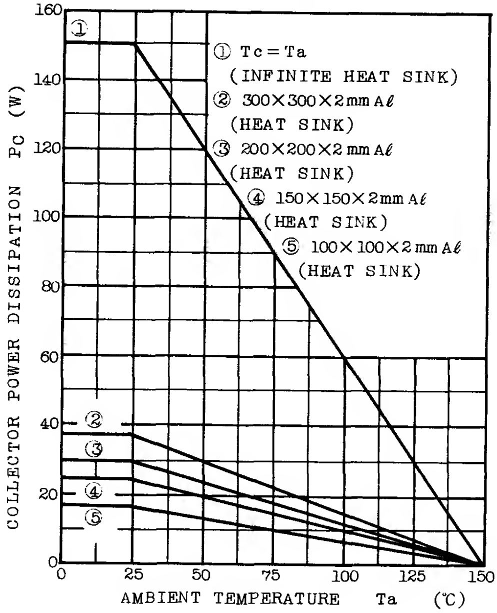
$V_{CE(sat)}$ – I_C



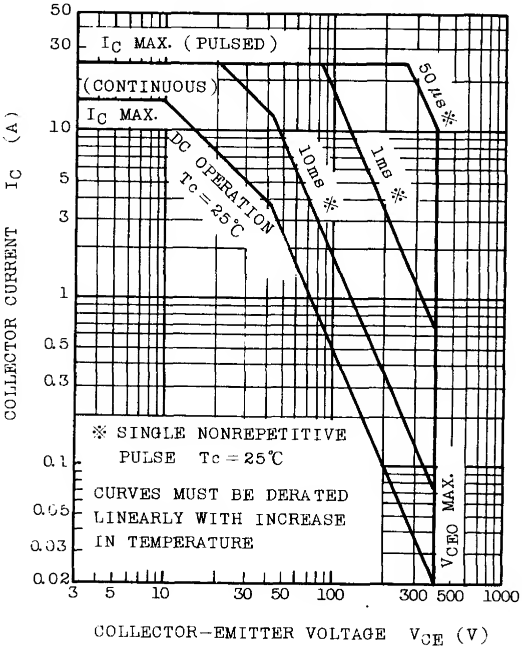
$V_{BE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA



2SD647A
2SD697A

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

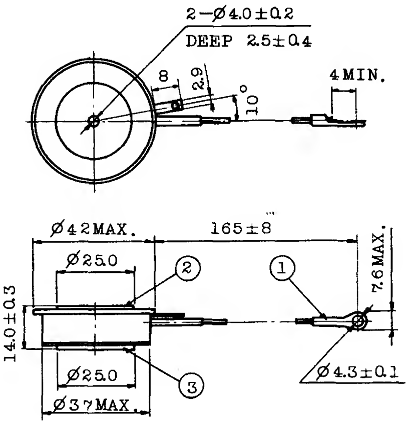
FEATURES:

- High Voltage : $V_{CEO(SUS)} \geqq 450V$ (2SD697A)
- Triple Diffused Design.
- Darlington Design.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD647A	V_{CBO}	800	V
	2SD697A		500	
Collector-Emitter Voltage	2SD647A	$V_{CEO(SUS)}$	600	V
	2SD697A		450	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	100	A
Emitter Current		I_E	-100	A
Base Current		I_B	6	A
Thermal Resistance (Double Side Cooling)		$R_{th(j-c)}$	0.13	°C/W
Junction Temperature		T_j	125	°C
Storage Temperature Range		T_{stg}	-40 ~ 150	°C
Mounting Force Required		F	400±40	kg

Unit in mm



1. BASE
2. EMITTER
3. COLLECTOR

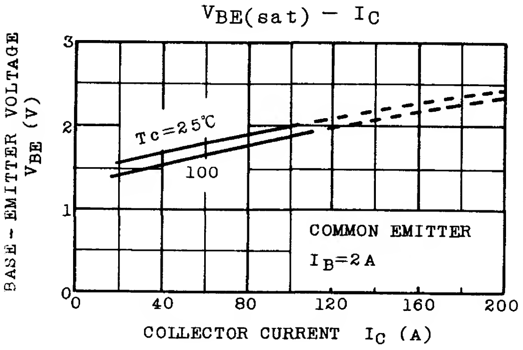
JEDEC	—
EIAJ	—
TOSHIBA	2−42A1A

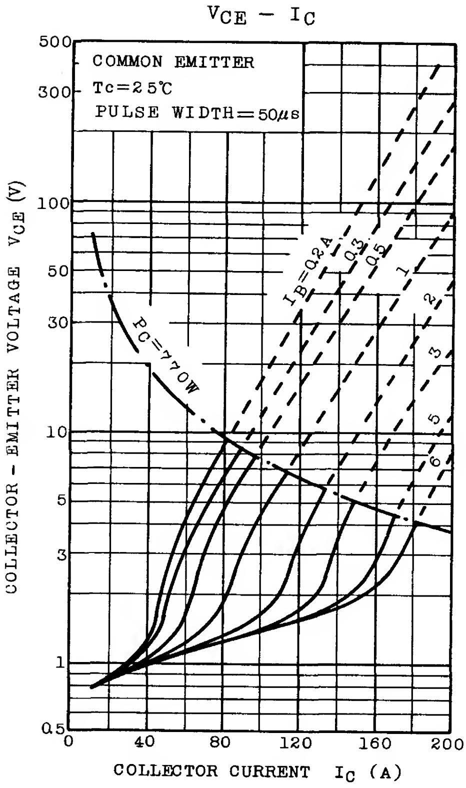
Weight : 70g

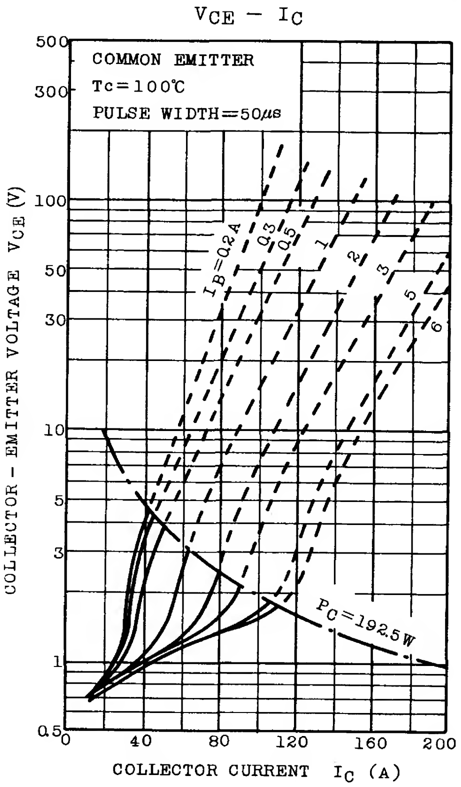
ELECTRICAL CHARACTERISTICS (Ta=25°C)

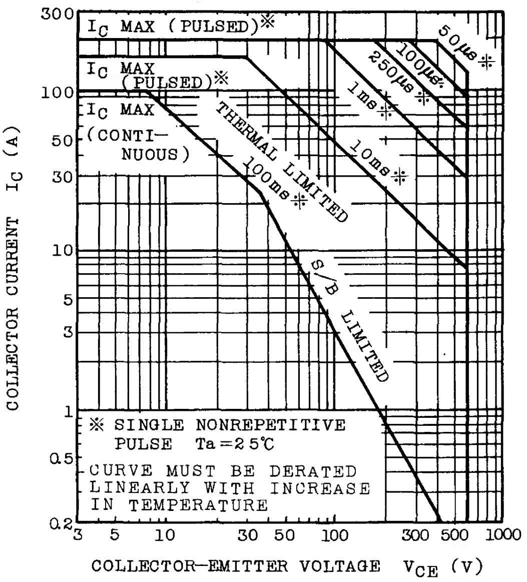
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=100A	100	-	-	
			V_{CE}=5V, I_C=50A	-	500	-	
Collector-Emitter Sustaining Voltage	2SD647A	$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	600	-	-	V
	2SD697A			450			
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=100A, I_B=2A (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current	2SD647A	I_{CBO}	V_{CB}=800V, I_E=0	-	-	2	mA
	2SD697A		V_{CB}=500V, I_E=0	-	-	2	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	200	mA
Switching Time	Turn-on Time	t_{on}	I_C=100A, I_{B1}=2A, $-I_{B2}$=2A, V_C=300V	-	2.5	-	μs
	Storage Time	t_{stg}		-	20	-	μs
	Fall Time	t_f		-	4	-	μs

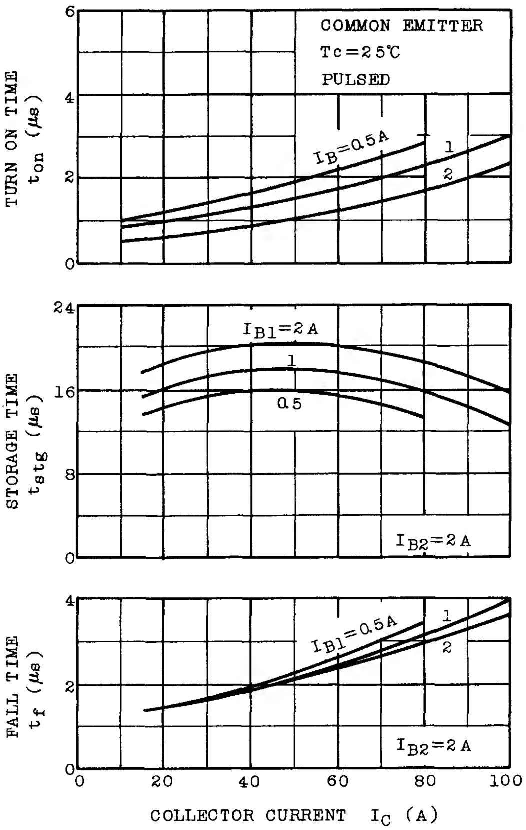
Note : Pulse Test; Pulse Width≦300μs , Duty Cycle≦3%
Mounting Force; F=400kg

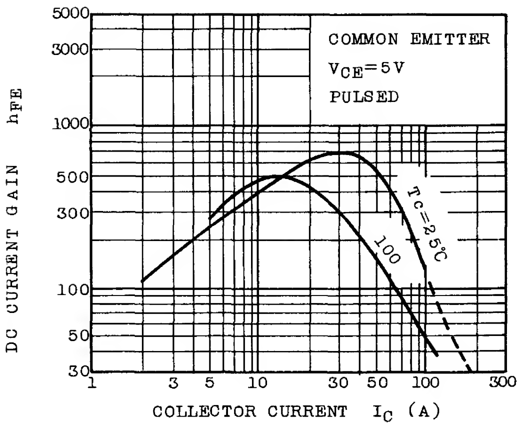

VBE(sat) − IC
BASE - EMITTER VOLTAGE VBE (V)
Tc=25℃
100
COMMON EMITTER
IB=2A
COLLECTOR CURRENT IC (A)
0
1
2
3
0
40
80
120
160
200

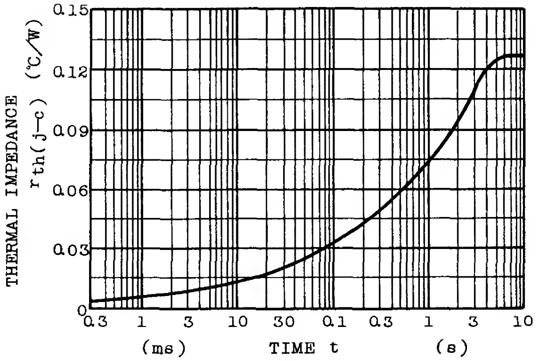

VCE − IC
COMMON EMITTER
Tc=25℃
PULSE WIDTH=50μs
COLLECTOR - EMITTER VOLTAGE VCE (V)
PC=770W
IB=0.2A
0.3
0.5
1
2
3
5
6
COLLECTOR CURRENT IC (A)
0.5
1
3
5
10
30
50
100
300
500
0
40
80
120
160
200


VCE − IC
COMMON EMITTER
Tc=100℃
PULSE WIDTH=50μs
COLLECTOR - EMITTER VOLTAGE VCE (V)
IB=0.2A
0.3
0.5
1
2
3
5
6
PC=192.5W
COLLECTOR CURRENT IC (A)
0.5
1
3
5
10
30
50
100
300
500
0
40
80
120
160
200


SAFE OPERATING AREA


SWITCHING CHARACTERISTICS

hFE – IC


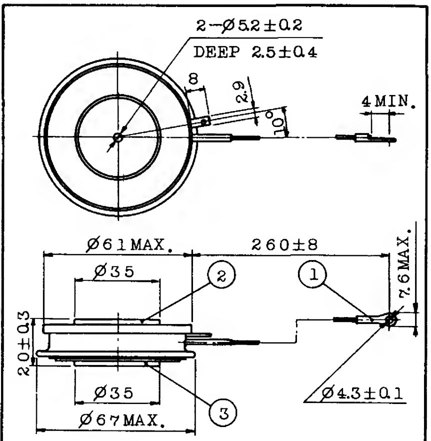
MAXIMUM TRANSIENT THERMAL IMPEDANCE (JUNCTION - CASE)


SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

2SD648A

HIGH POWER SWITCHING APPLICATIONS.
DC MOTOR CONTROL APPLICATIONS.
ELECTRIC CAR APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. EMITTER
3. COLLECTOR

JEDEC	−
EIAJ	−
TOSHIBA	2−67A1A

Weight : 250g

FEATURES:

- High Voltage : $V_{CEO(SUS)}$=300V
- Triple Diffused Design.
- Darlington Design.

MAXIMUM RATINGS (Ta=25°C)

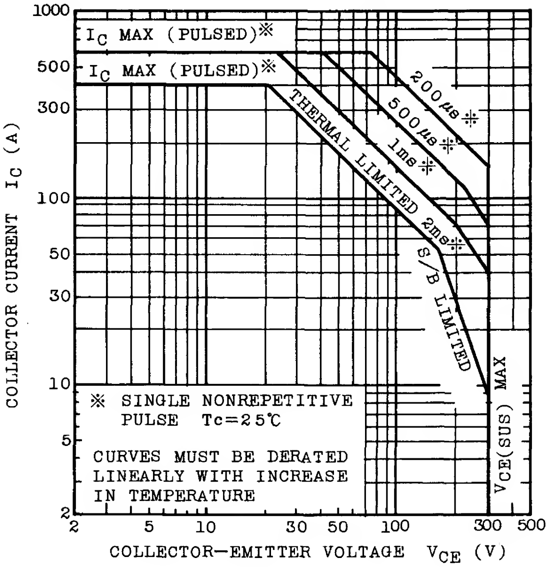
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	300	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	400	A
Emitter Current	I_E	-400	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	-40 ~ 150	°C
Mounting Force Required	F	1000±100	kg

ELECTRICAL CHARACTERISTICS (Ta=25°C)

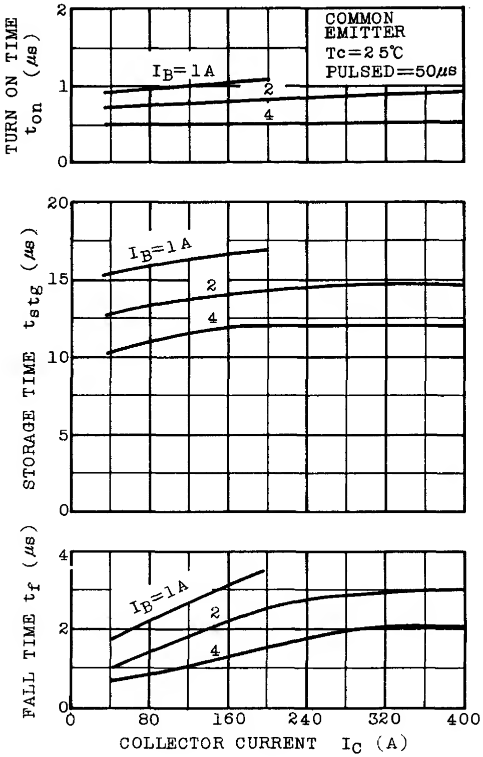
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=400A	100	400	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	300	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=400A, I_B=8A (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=400A, I_B=8A (Note)	-	-	2.5	V
Collector Cut-off Current		I_{CEO}	V_{CE}=300V, I_B=0	-	1.0	10	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=4V, I_C=0	-	50	250	mA
Switching Time	Turn-on Time	t_{on}	I_C=400A, I_{B1}=4A, $-I_{B2}$=4A, V_C=100V	-	1.0	3.0	μs
	Storage Time	t_{stg}		-	8	13	μs
	Fall Time	t_f		-	2	3.0	μs

Note: Pulse Test, Pulse Width ≦300μs, Duty Cycle≦3%
Mounting Force; F=1000kg

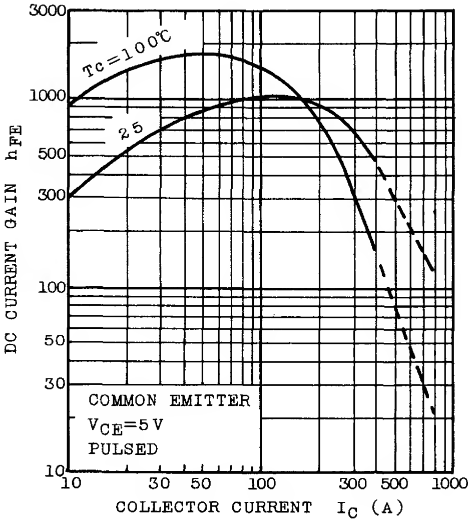
SAFE OPERATING AREA



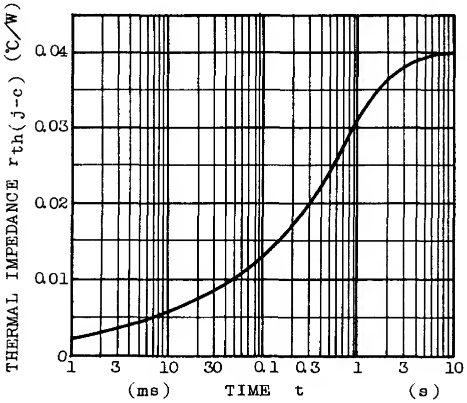
SWITCHING CHARACTERISTICS

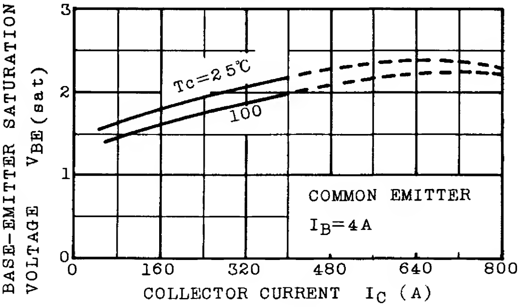


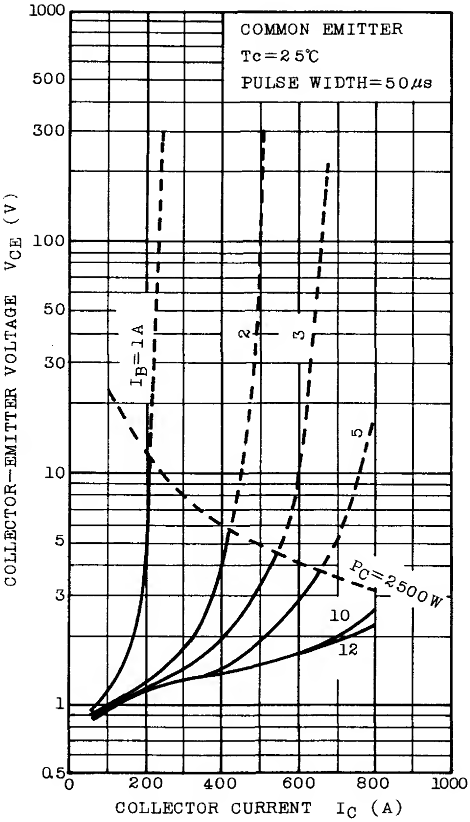
h_{FE} – I_C

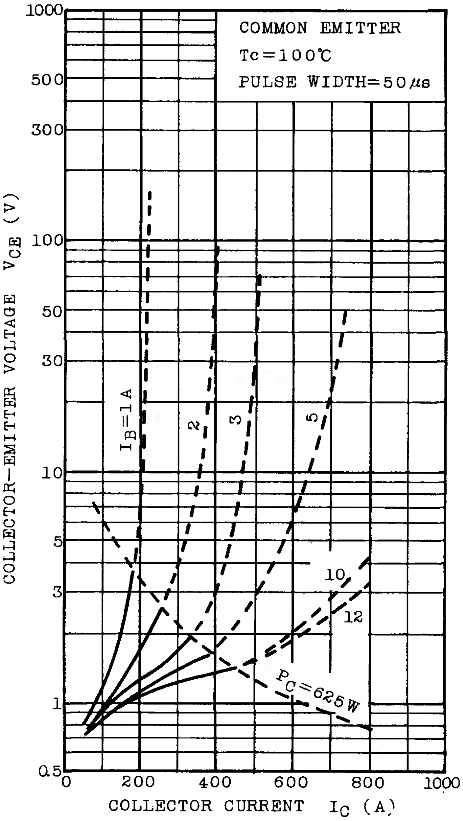


$r_{th(j-c)}$–t (JUNCTION-CASE)




$V_{BE(sat)}$ — I_C


V_{CE} — I_C


V_{CE} — I_C

2SD664

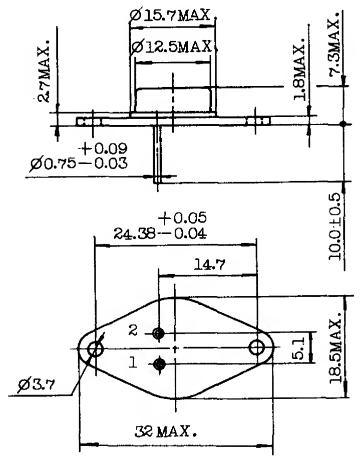
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000(Min.)(V_{CE}=3V, I_C=3A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V (Max.)(I_C=3A)
- Monolithic Cnstruction with Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

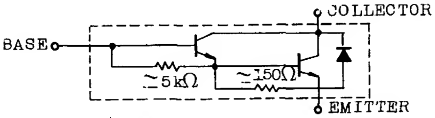
JEDEC	TO − 66
EIAJ	TC − 16A, TB − 23
TOSHIBA	2 − 13A1A

Mounting Kit No. AC74
Weight : 5.9g

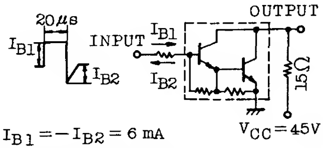
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	0.2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

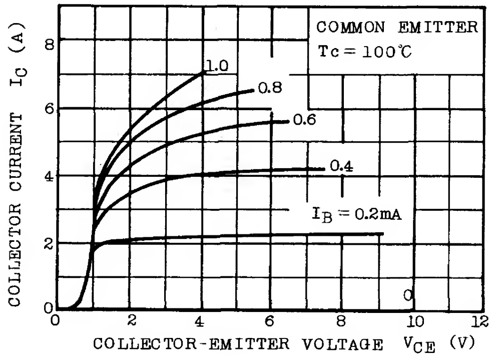
EQUIVALENT CIRCUIT



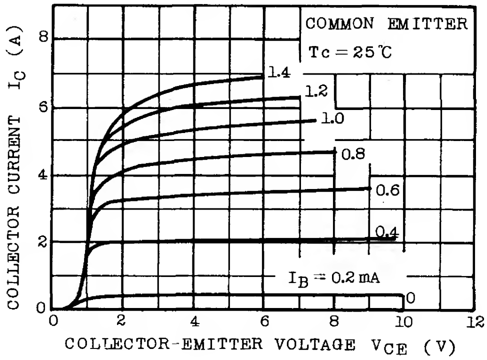
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	−	−	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=3V, I_C=3A	2000	−	15000	
		$h_{FE(2)}$	V_{CE}=3V, I_C=7A	1000	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	I_C=3A, I_B=6mA	−	0.9	1.5	V
		$V_{CE(sat)(2)}$	I_C=7A, I_B=14mA	−	1.2	2.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=6mA	−	1.5	2.5	V
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=-I_{B2}=6$ mA DUTY CYCLE≦1%	−	0.8	−	μs
	Storage Time	t_{stg}		−	3.0	−	
	Fall Time	t_f		−	2.5	−	

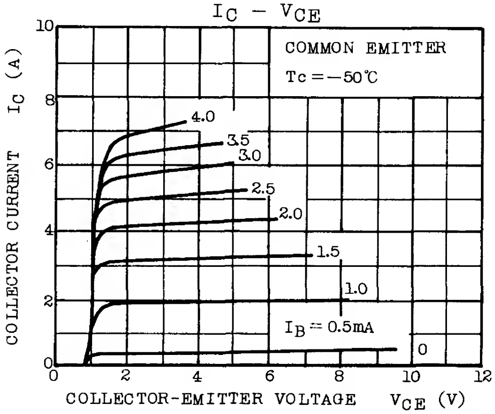
$I_C - V_{CE}$



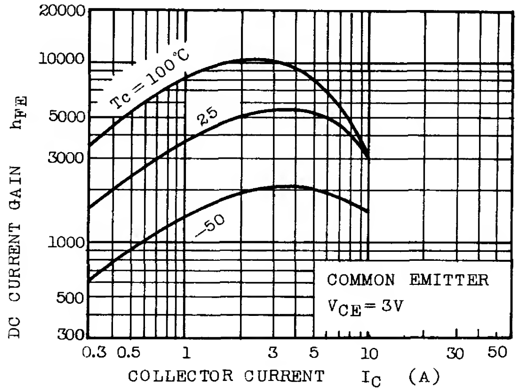
$I_C - V_{CE}$



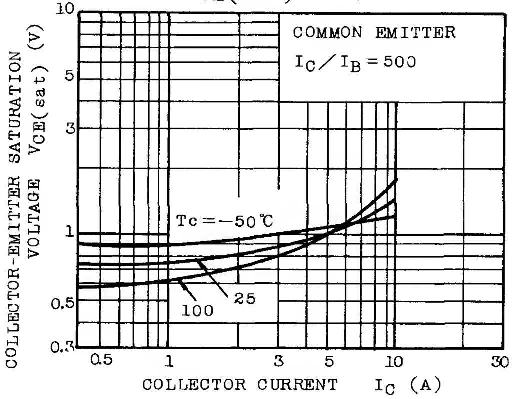
$I_C - V_{CE}$



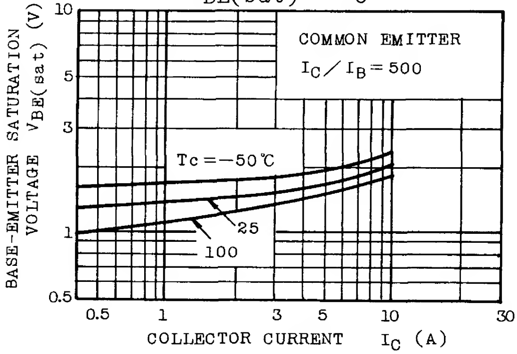
$h_{FE} - I_C$



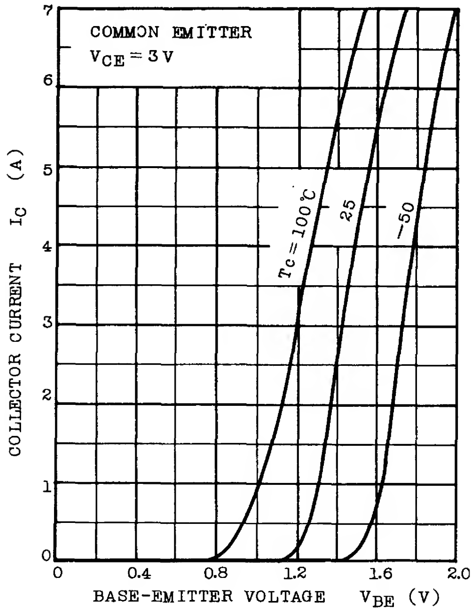
$V_{CE(sat)} - I_C$



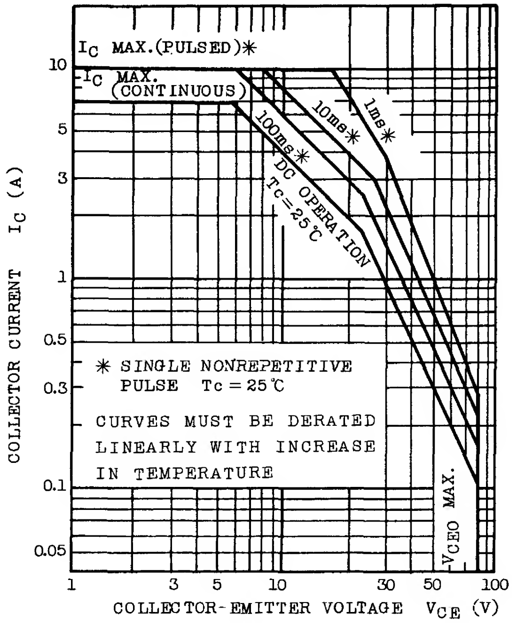
$V_{BE(sat)} - I_C$



I_C – V_{BE}



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD683
2SD683A

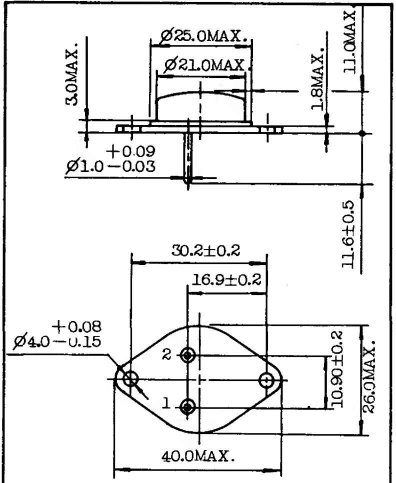
HIGH VOLTAGE AND HIGH POWER SWITCHING APPLICATIONS.
MOTOR DRIVE APPLICATIONS.

FEATURES :

- High DC Current Gain : h_{FE}=500(Min.)(V_{CE}=5V, I_C=5A)
- High Voltage : $V_{CEO(SUS)}$=450V (2SD683A)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

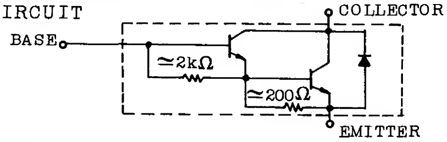
JEDEC	TO — 3
EIAJ	TC — 3, TB — 3
TOSHIBA	2 — 21A1A

Mounting Kit No. AC73
Weight : 12.9g

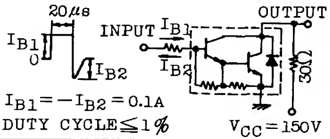
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage	2SD683	V_{CEO}	400	V
	2SD683A		450	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	15	A
Base Current		I_B	2	A
Collector Power Dissipation (Tc=25°C)		P_C	150	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65∿150	°C

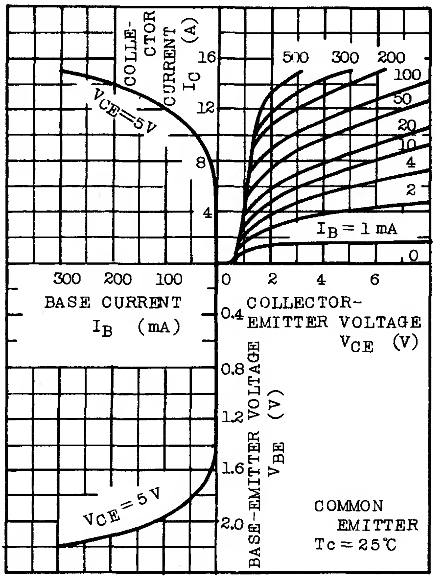
EQUIVALENT CIRCUIT



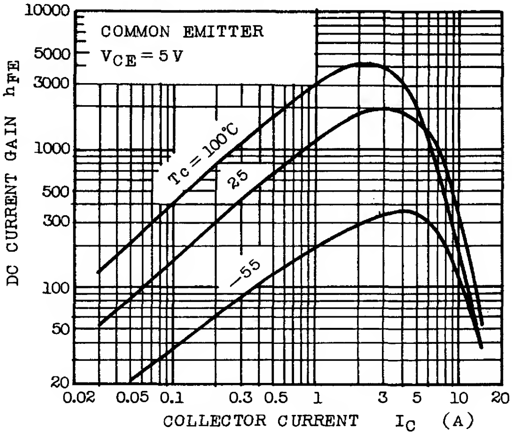
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	−	−	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	30	mA
Collector-Emitter Sustaining Voltage	2SD683	$V_{CEO(SUS)}$	I_C=5A, L=10mH	400	−	−	V
	2SD683A			450	−	−	
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=5A	500	−	−	
		$h_{FE(2)}$	V_{CE}=5V, I_C=15A	30	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=0.2A	−	−	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=0.2A	−	−	2.5	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=10A, I_B=0	−	−	3.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	−	100	−	pF
Switching Time	Turn-on Time	t_{on}	 $I_{B1}=-I_{B2}$=0.1A DUTY CYCLE≦1% V_{CC}=150V	−	0.4	−	μs
	Storage Time	t_{stg}		−	15	−	
	Fall Time	t_f		−	3	−	

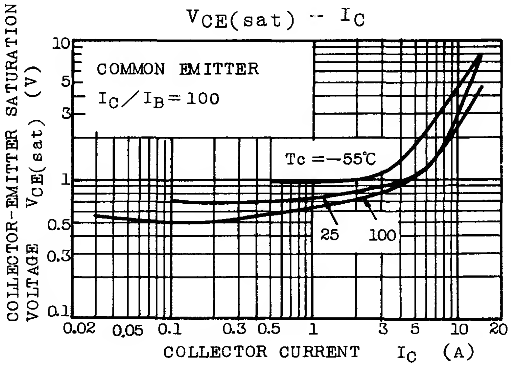
STATIC CHARACTERISTICS



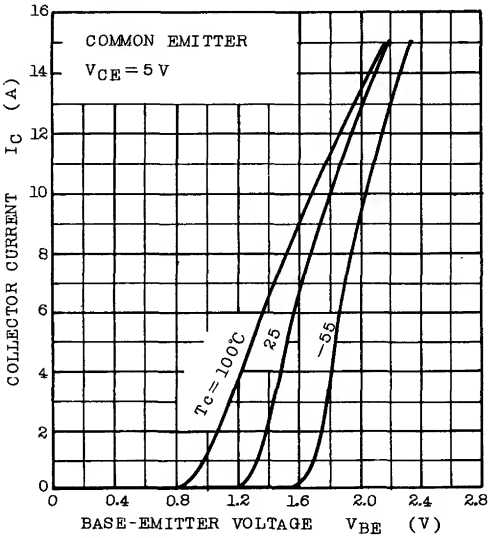
h_{FE} – I_C



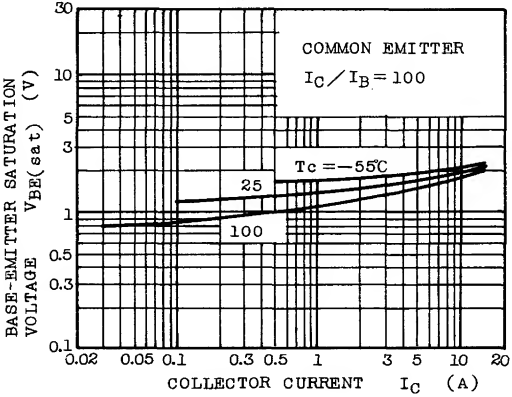
$V_{CE(sat)}$ – I_C

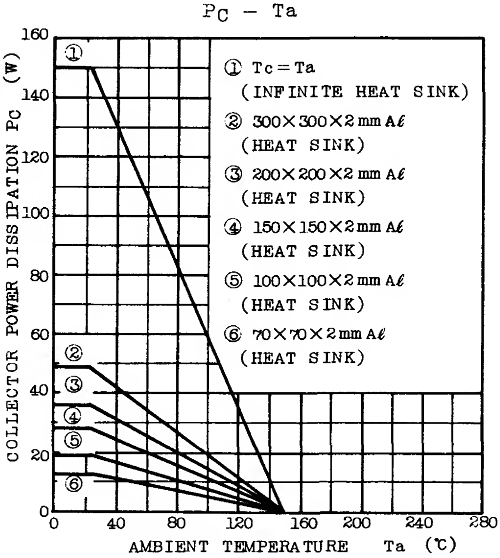


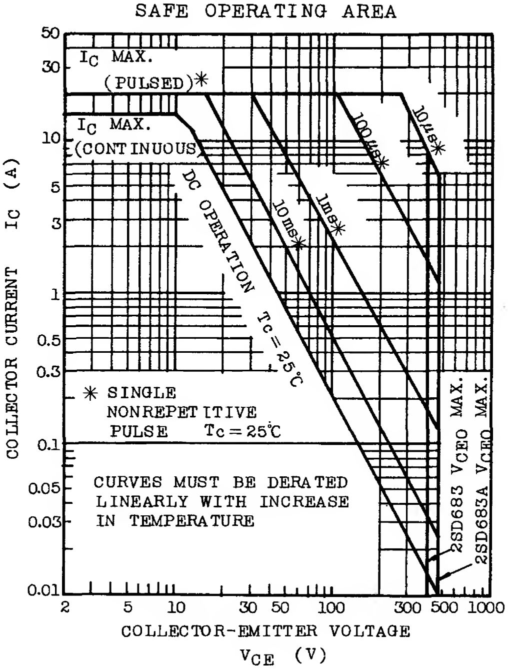
I_C – V_{BE}



$V_{BE(sat)}$ – I_C




PC − Ta
COLLECTOR POWER DISSIPATION PC (W)
AMBIENT TEMPERATURE Ta (℃)
0
20
40
60
80
100
120
140
160
0
40
80
120
160
200
240
280
① Tc = Ta (INFINITE HEAT SINK)
② 300×300×2 mm Aℓ (HEAT SINK)
③ 200×200×2 mm Aℓ (HEAT SINK)
④ 150×150×2 mm Aℓ (HEAT SINK)
⑤ 100×100×2 mm Aℓ (HEAT SINK)
⑥ 70×70×2 mm Aℓ (HEAT SINK)
①
②
③
④
⑤
⑥

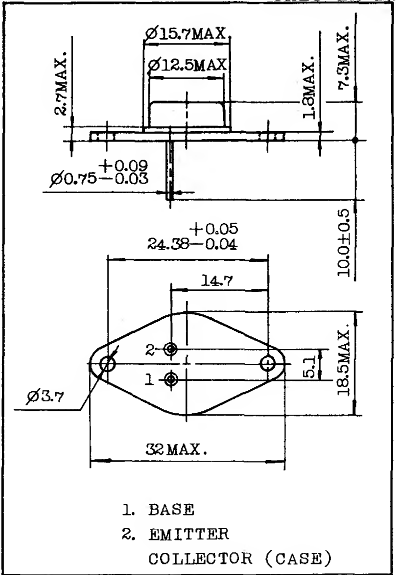

SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
COLLECTOR-EMITTER VOLTAGE VCE (V)
50
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
2
5
10
30
50
100
300
500
1000
IC MAX. (PULSED)✳
IC MAX. (CONTINUOUS)
DC OPERATION Tc = 25°C
10ms✳
1ms✳
100μs✳
10μs✳
✳ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
2SD683 VCEO MAX.
2SD683A VCEO MAX.

2SD684

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO − 66
EIAJ	TC − 16A, TB − 23
TOSHIBA	2 − 13A1A

Mounting Kit No. AC74
Weight : 5.9g

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

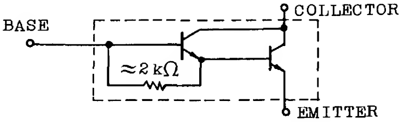
FEATURES:

- High DC Current Gain
  : h_{FE}=1500 (Min.) (V_{CE}=2V, I_C=2A)

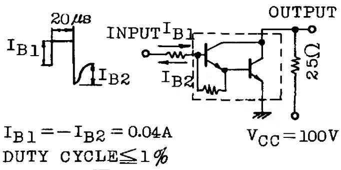
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

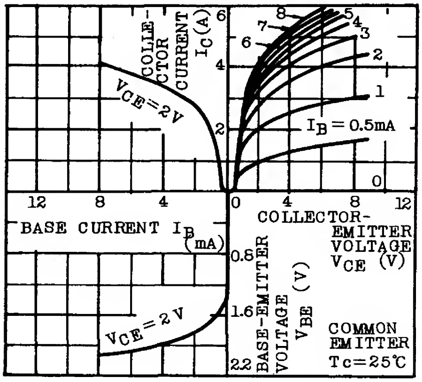
EQUIVALENT CIRCUIT



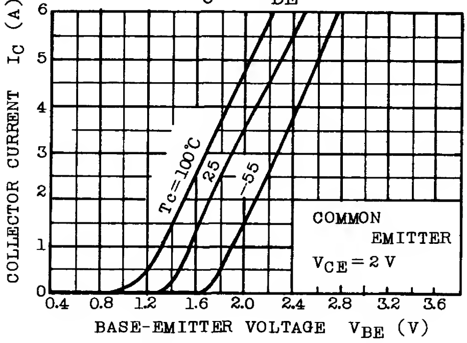
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	300	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	1500	-	-	
		$h_{FE(2)}$	V_{CE}=2V I_C=4A	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

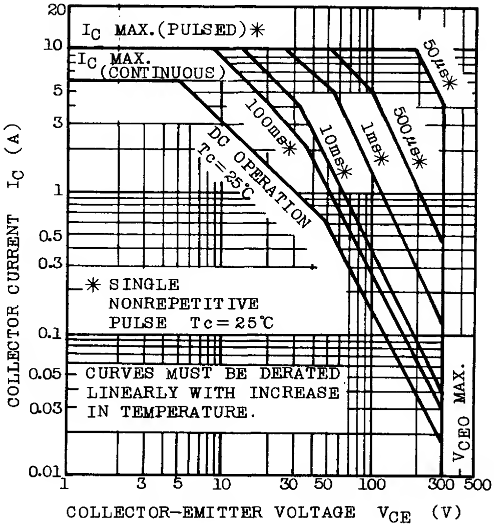
STATIC CHARACTERISTICS



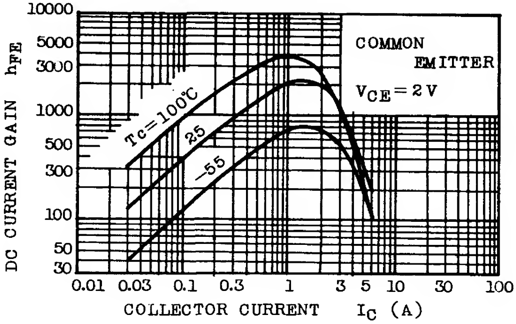
I_C – V_{BE}



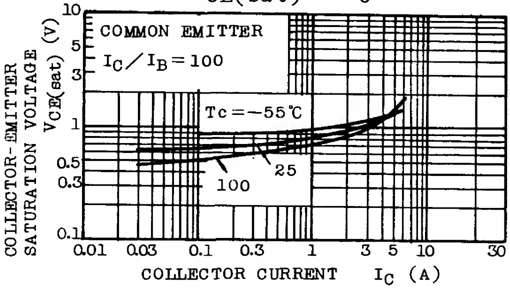
SAFE OPERATING AREA



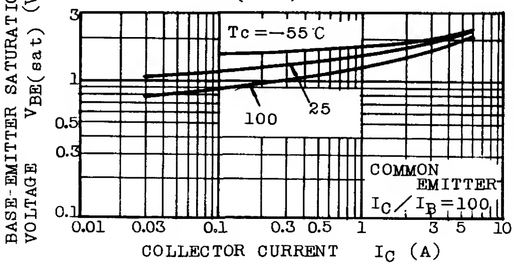
h_{FE} – I_C



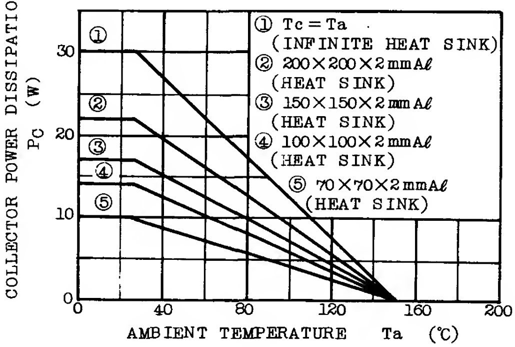
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



P_C – Ta



2SD684A

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

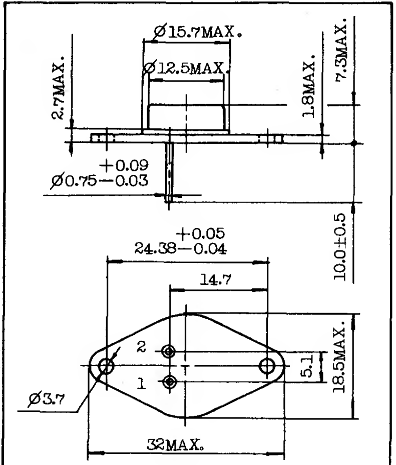
IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=600 (Min.) (V_{CE}=2V, I_C=2A)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

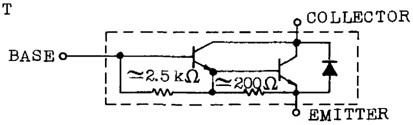
JEDEC	TO − 66
EIAJ	TC − 16A, TB − 23
TOSHIBA	2 − 13A1A

Mounting kit No.AC74
Weight : 5.9g

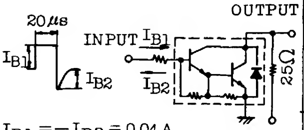
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

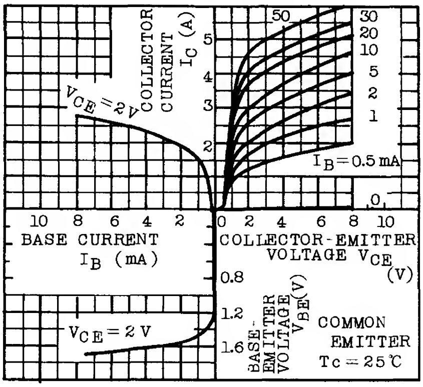
EQUIVALENT CIRCUIT



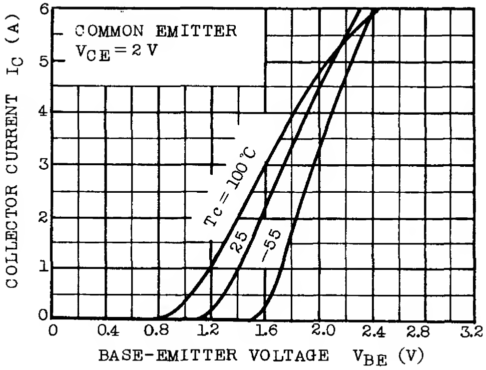
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	600	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=4A, I_B=0	-	-	3.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1} = −I_{B2} = 0.04 A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	µs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

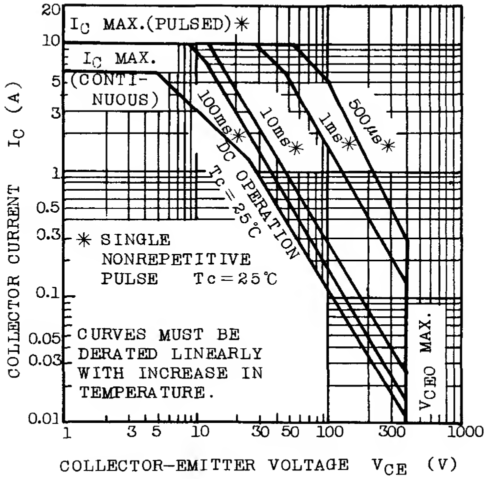
STATIC CHARACTERISTICS



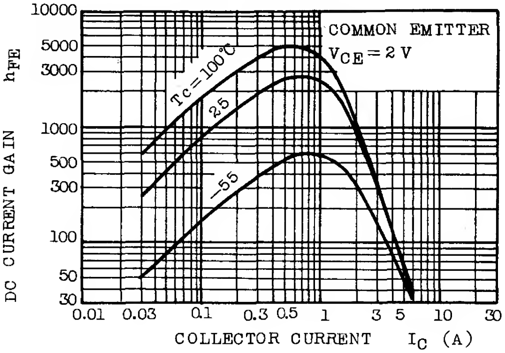
I_C – V_{BE}



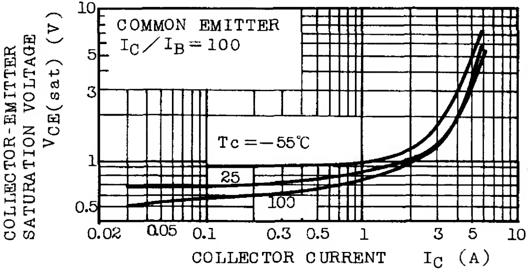
SAFE OPERATING AREA



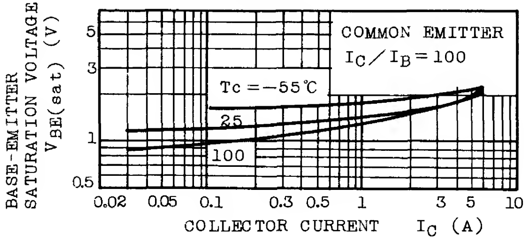
h_{FE} – I_C



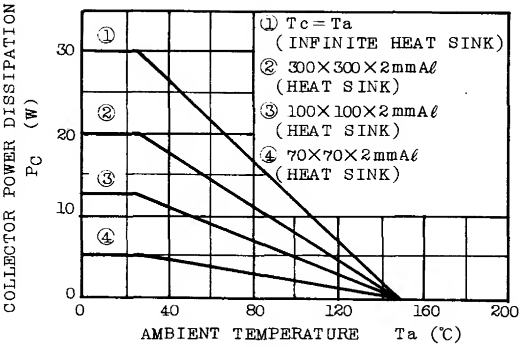
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



P_C – Ta



2SD685

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

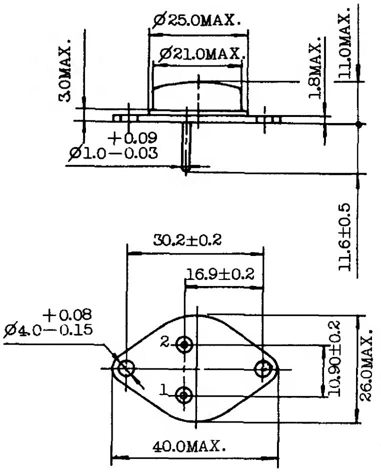
HIGH VOLTAGE AND HIGH POWER SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

FEATURES :

- High DC Current Gain
  : $h_{FE}=400$ (Min.)($V_{CE}=2V$, $I_C=4A$)
- High Reverse Energy : $E_{S/B}=245mJ$ (Min.)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

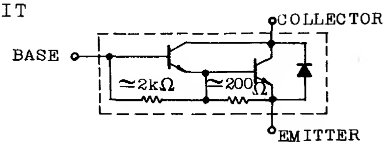
JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting kit No. AC73
Weight : 12.9g

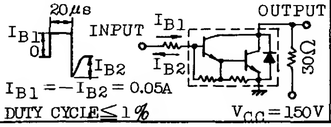
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

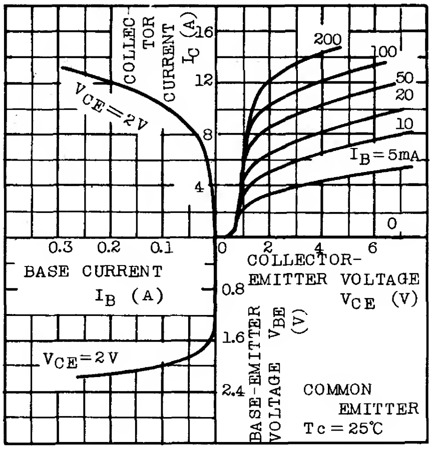
EQUIVALENT CIRCUIT



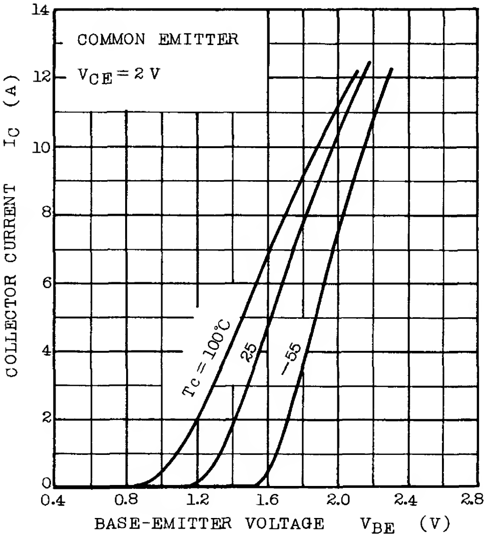
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V$, $I_E=0$	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	20	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(sus)}$	$I_C=6A$, $L=10mH$	400	-	-	V
Reverse Energy		$E_{S/B}$	$L=10mH$, $I_{CP}=7A$ (Note)	245	-	-	mJ
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V$, $I_C=4A$	400	-	-	
		$h_{FE(2)}$	$V_{CE}=2V$, $I_C=8A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=8A$, $I_B=0.08A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=8A$, $I_B=0.08A$	-	-	2.5	V
Emitter-Collector Forward Voltage		V_{ECF}	$I_E=10A$, $I_B=0$	-	-	3.0	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	90	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT I_{B1} 0 I_{B2} 30Ω $I_{B1}=-I_{B2}=0.05A$ DUTY CYCLE≤1% $V_{CC}=150V$	-	1.0	-	μs
	Storage Time	t_{stg}		-	12	-	
	Fall Time	t_f		-	5	-	

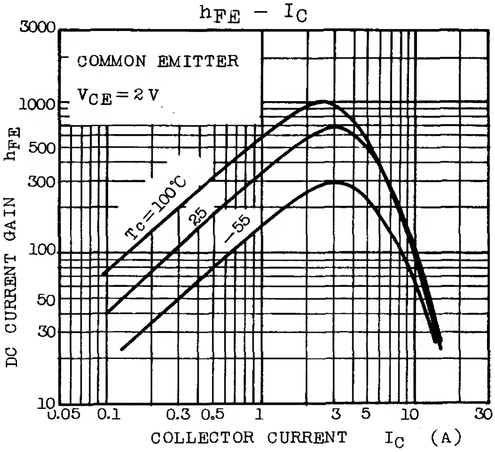
Note: $E_{S/B}$ is defined as the energy at which second breakdown occurs under the base open circuit. $E_{S/B}=1/2L\ I_{CP}^2$, Where L is a series load or leakage inductance and



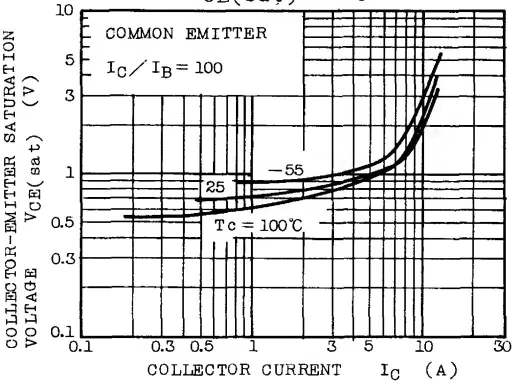
STATIC CHARACTERISTICS



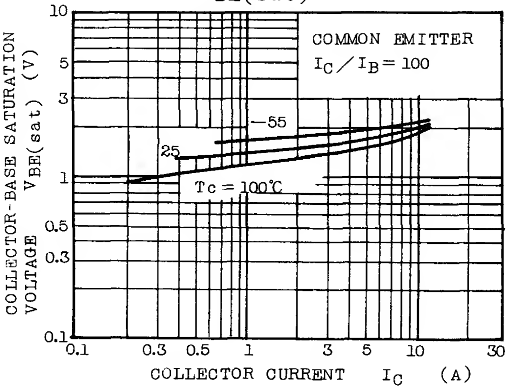
I_C – V_{BE}



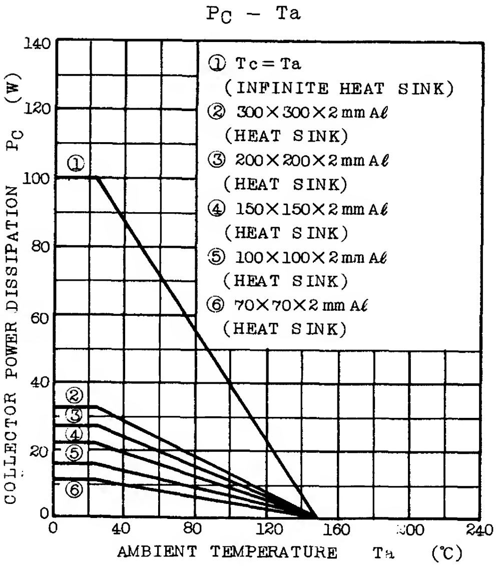
h_{FE} – I_C

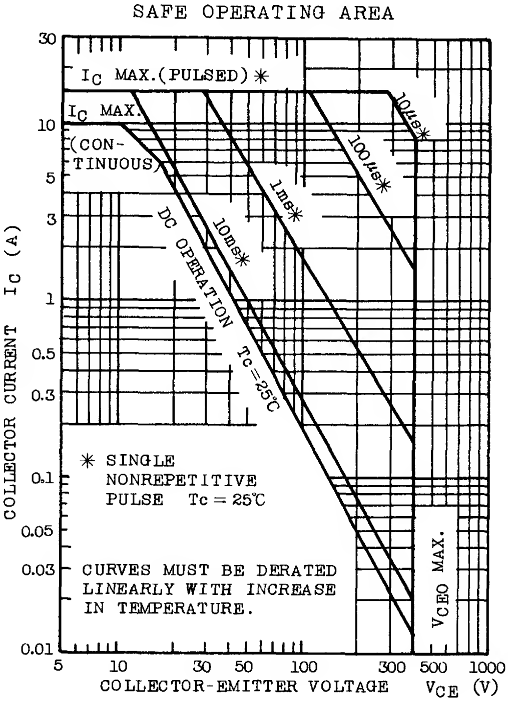


$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C


PC – Ta
COLLECTOR POWER DISSIPATION PC (W)
140
120
100
80
60
40
20
0
0
40
80
120
160
200
240
AMBIENT TEMPERATURE Ta (℃)
① Tc = Ta (INFINITE HEAT SINK)
② 300×300×2 mm Aℓ (HEAT SINK)
③ 200×200×2 mm Aℓ (HEAT SINK)
④ 150×150×2 mm Aℓ (HEAT SINK)
⑤ 100×100×2 mm Aℓ (HEAT SINK)
⑥ 70×70×2 mm Aℓ (HEAT SINK)
①
②
③
④
⑤
⑥


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
5
10
30
50
100
300
500
1000
COLLECTOR-EMITTER VOLTAGE VCE (V)
IC MAX.(PULSED)✳
IC MAX. (CON-TINUOUS)
10μs✳
100μs✳
1ms✳
10ms✳
DC OPERATION Tc = 25℃
✳ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SD686

SWITCHING APPLICATIONS.

HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

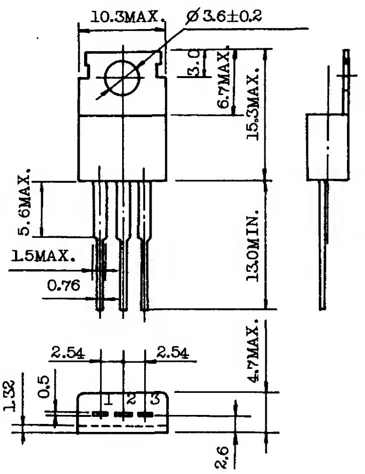
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain : h_{FE}=2000 (Min.)(V_{CE}=2V,I_C=1A)
- Complementary to 2SB676.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220 AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

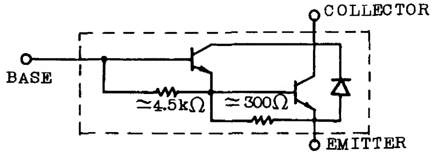
Mounting Kit No. AC75

Weight : 1.9g

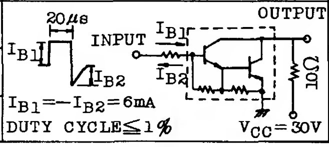
MAXIMUM RATINGS (Ta=25°C)

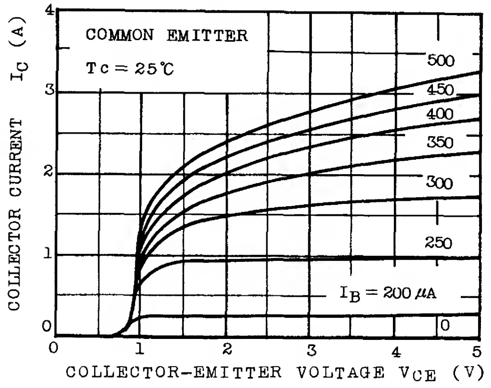
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Continuous Collector Current	I_C	4	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	Tstg	-55∿150	°C

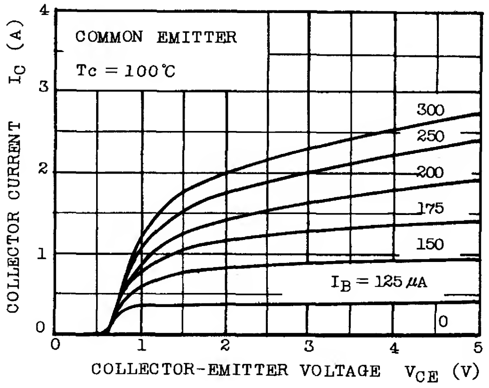
EQUIVALENT CIRCUIT

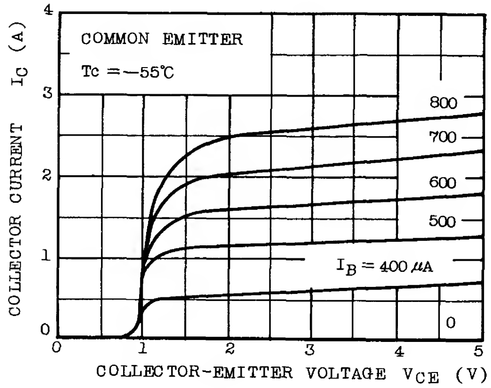


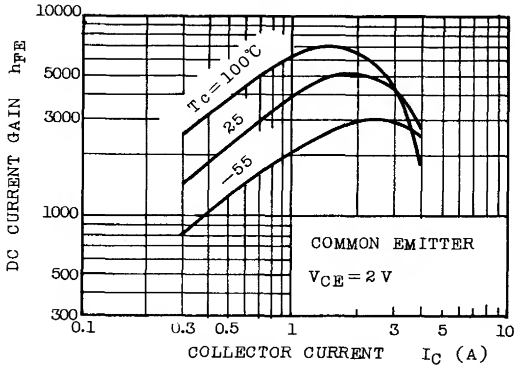
ELECTRICAL CHARACTERISTICS (Ta=25°C)

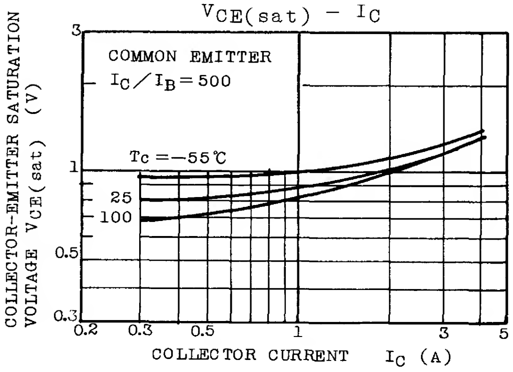
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=3A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=6mA	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=3A, I_B=6mA	-	-	2.0	
Switching Time	Turn-on Time	t_{on}	 20μs, INPUT, OUTPUT, I_{B1}, I_{B2}, 10Ω I_{B1}=$-I_{B2}$=6mA DUTY CYCLE≦1% V_{CC}=30V	-	0.2	-	μs
	Storage Time	tstg		-	1.5	-	
	Fall Time	t_f		-	0.6	-	

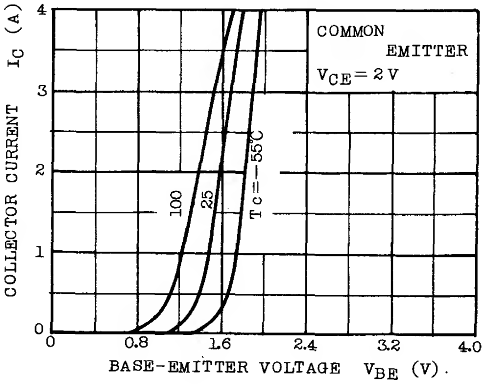

I_C – V_{CE}

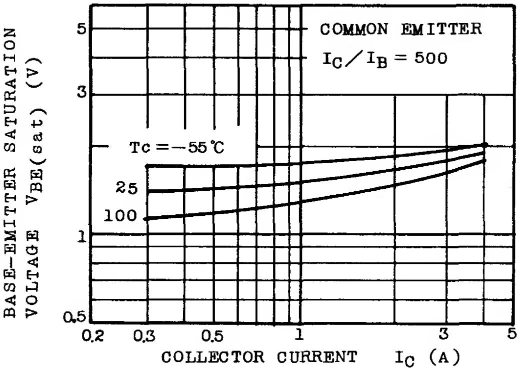

I_C – V_{CE}


I_C – V_{CE}

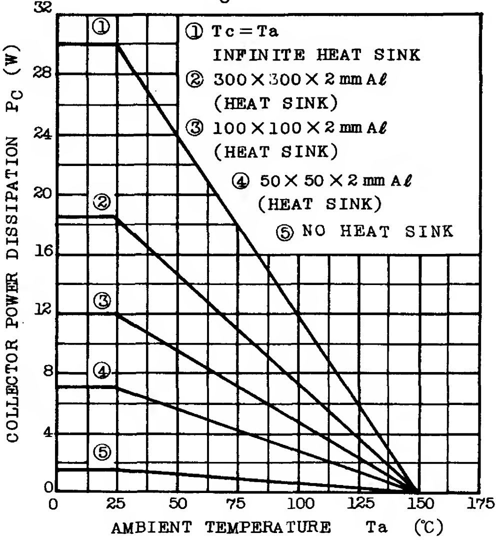

h_{FE} – I_C


$V_{CE(sat)}$ – I_C

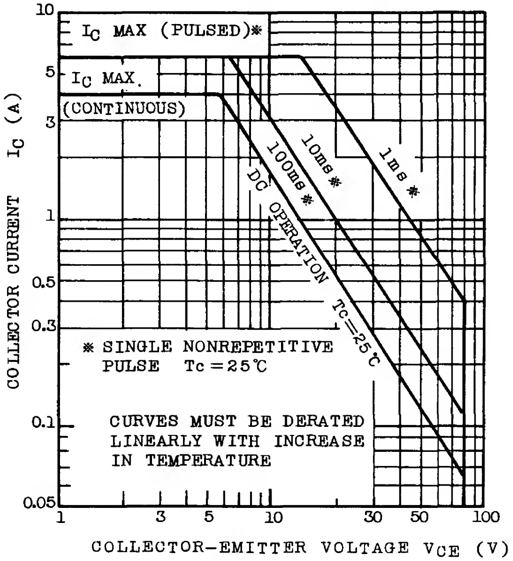

I_C – V_{BE}



$V_{BE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA

2SD687

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

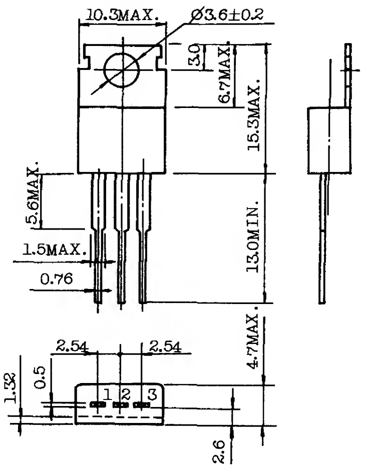
SWITCHING APPLICATIONS.

HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

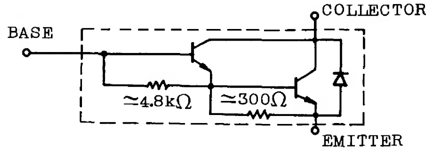
FEATURES :

- High DC Current Gain
  : h_{FE}=2000(Min.)(V_{CE}=2V, I_C=1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.)(I_C=2A)

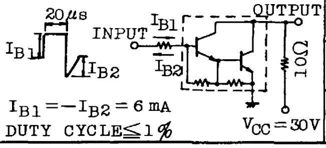
MAXIMUM RATINGS (Ta=25°C)

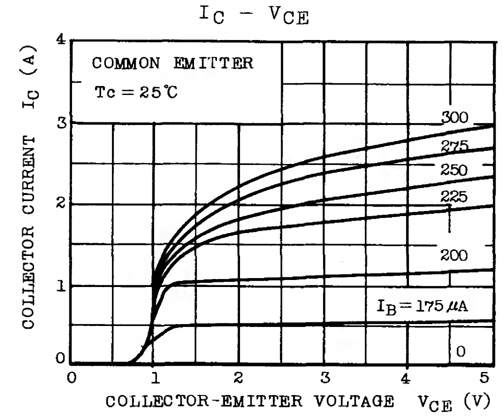
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	40	V
Emitter-Base Voltage	V_{EBO}	5	V
Continuous Collector Current	I_C	3	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

EQUIVALENT CIRCUIT

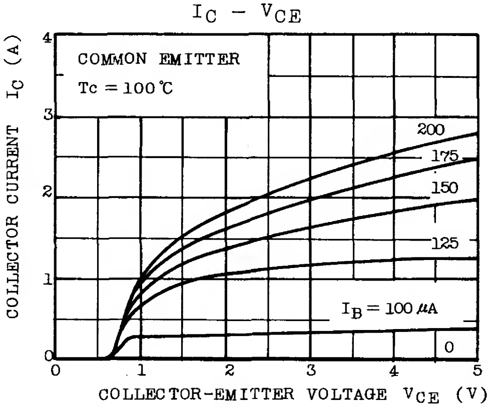


ELECTRICAL CHARACTERISTICS (Ta=25°C)

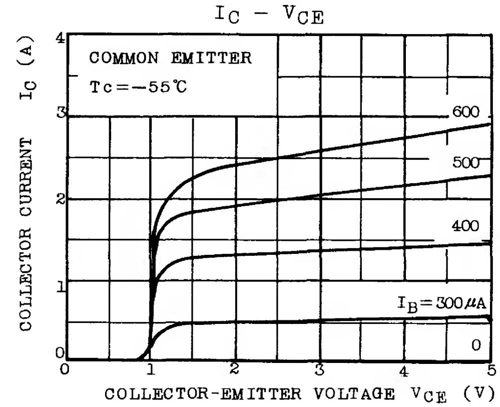
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=25mA, I_B=0	40	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=3A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=2A, I_B=4mA	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=2A, I_B=4mA	-	-	2.0	
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT I_{B1} I_{B2} 10Ω I_{B1}=−I_{B2}=6 mA DUTY CYCLE≦1% V_{CC}=30V	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.2	-	



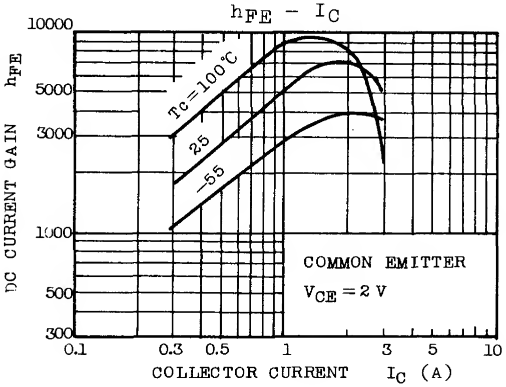
I_C – V_{CE}



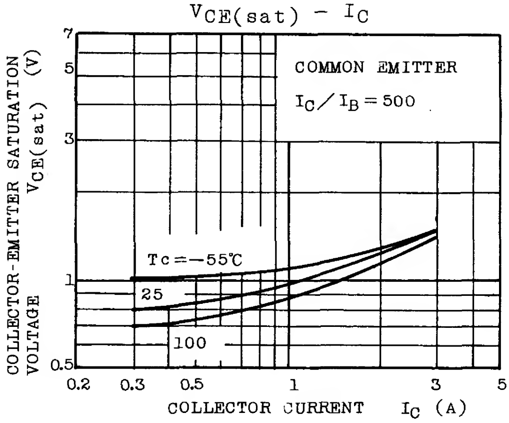
I_C – V_{CE}



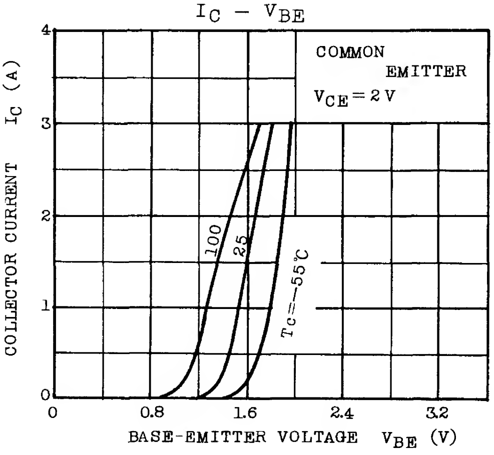
I_C – V_{CE}



h_{FE} – I_C

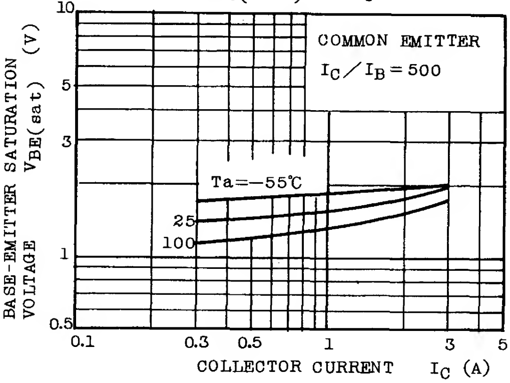


$V_{CE(sat)}$ – I_C

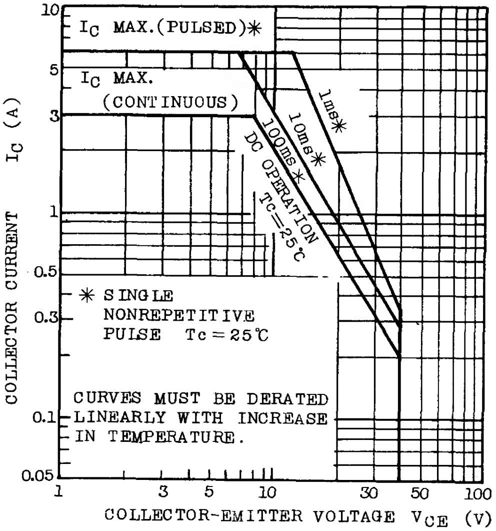


I_C – V_{BE}

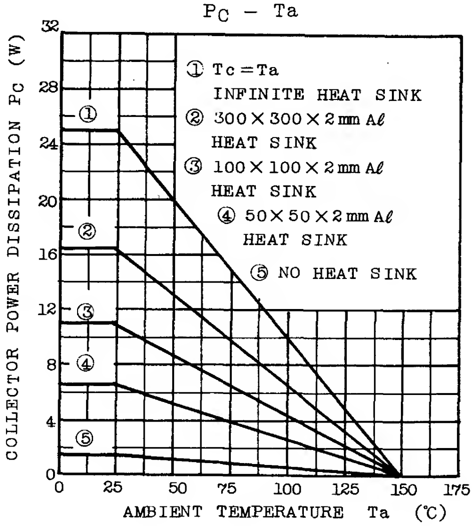
$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



P_C − Ta



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

2SD688

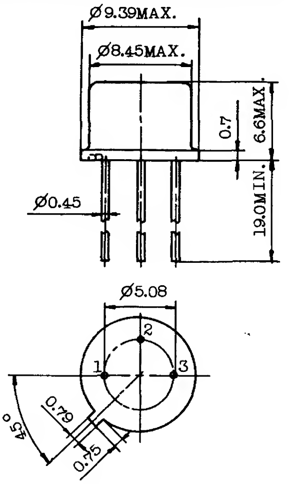
LOW FREQUENCY MEDIUM POWER AMPLIFIER AND MEDIUM SPEED SWITCHING APPLICATIONS.

PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=1000 (Min.) (V_{CE}=2V, I_C=1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V (Max.) (I_C=1A)
- Complementary to 2SB678

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR(CASE)

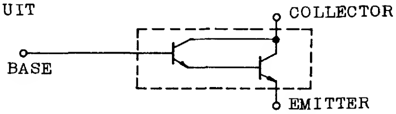
JEDEC	TO − 39
EIAJ	TC − 5, TB − 5B
TOSHIBA	2 − 8B1A

Weight : 1.13g

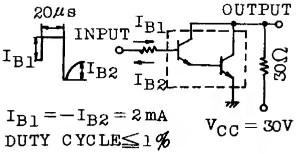
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	100	V
Emitter-Base Voltage		V_{EBO}	10	V
Continuous Collector Current		I_C	1.5	A
Collector Power Dissipation	Ta=25°C	P_C	0.8	W
	Tc=25°C		8	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65~175	°C

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=10V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	100	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=5mA, I_C=0	10	-	-	V
DC Current Gain		h_{FE}	V_{CE}=2V, I_C=0.1A	2000	-	-	
			V_{CE}=2V, I_C=1A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=2mA	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=2mA	-	-	2.5	V
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 30Ω V_{CC} = 30V	-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f	I_{B1} = −I_{B2} = 2mA DUTY CYCLE≤1%	-	0.7	-	

2SD689

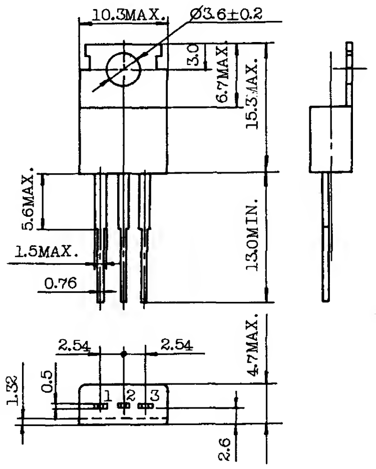
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

LOW FREQUENCY MEDIUM POWER AMPLIFIER AND MEDIUM SPEED SWITCHING APPLICATIONS.
PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain : h_{FE}=1000(Min.)(V_{CE}=2V, I_C=1A)
- Low Saturation Voltage : $V_{CE(sat)}$=1.5V(Max.)(I_C=1A)
- Complementary to 2SB679.

INDUSTRIAL APPLICATIONS
Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

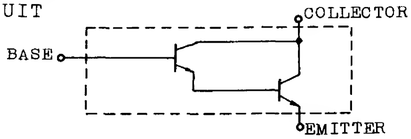
JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

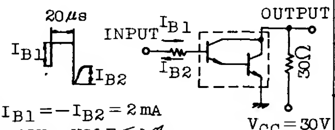
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	10	V
Continuous Collector Current	I_C	1.5	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=10V, I_C=0	-	-	10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	I_C=10mA, I_B=0	100	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	I_E=5mA, I_C=0	10	-	-	V
DC Current Gain		h_{FE}	V_{CE}=2V, I_C=0.1A	2000	-	-	
			V_{CE}=2V, I_C=1A	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=2mA	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=2mA	-	-	2.5	V
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 30Ω V_{CC}=30V I_{B1}=−I_{B2}=2mA DUTY CYCLE≦1%	-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.7	-	

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

2SD698

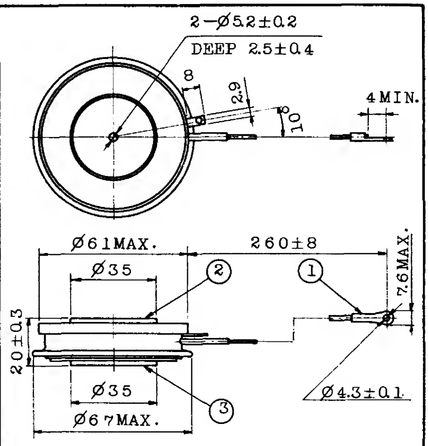
INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATION.

DC MOTOR CONTROL APPLICATION.

ELECTRIC CAR APPLICATION.

Unit in mm



1. BASE
2. EMITTER
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−67A1A

Weight : 250g

FEATURES:

- High Voltage : $V_{CE(SUS)} > 200V$
- Triple Diffused Design.
- Darlington Design.

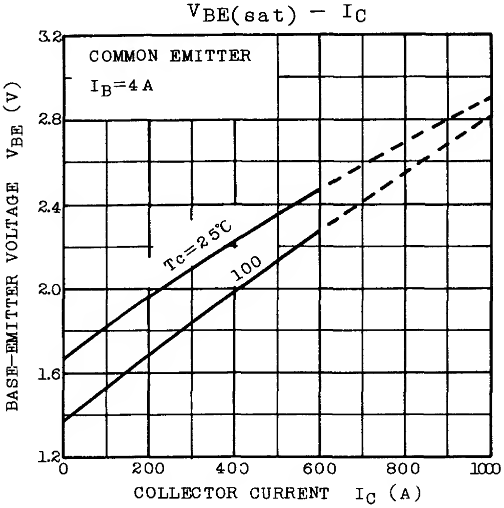
MAXIMUM RATINGS (Ta=25°C)

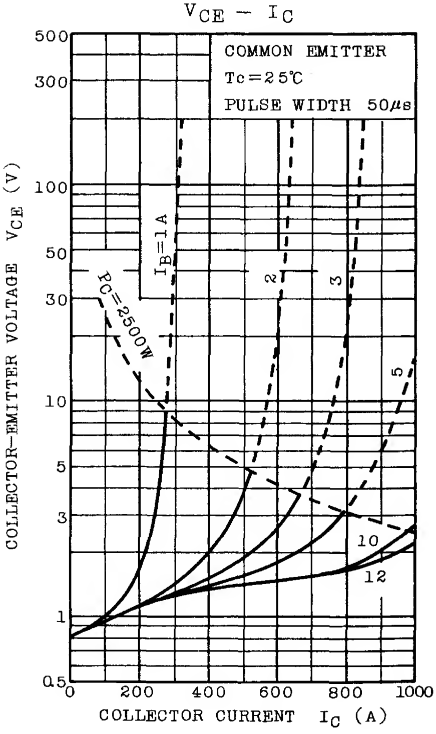
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	$V_{CE(SUS)}$	200	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	600	A
Emitter Current	I_E	-600	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	-40~150	°C
Mounting Force Required	F	1000±100	kg

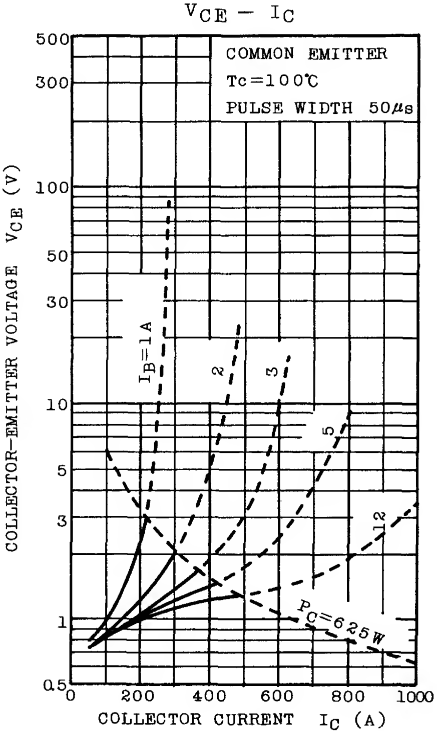
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=600A	150	400	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	200	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=600A, I_B=8A (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CEO}	V_{CE}=200V, I_B=0	-	1.0	10	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=4V, I_C=0	-	50	250	mA
Switching Time	Turn on Time	t_{on}	I_C=600A, I_{B1}=4A, $-I_{B2}$=4A, V_C=100V	-	2.0	-	μs
	Storage Time	t_{stg}		-	8	-	μs
	Fall Time	t_f		-	3	-	μs

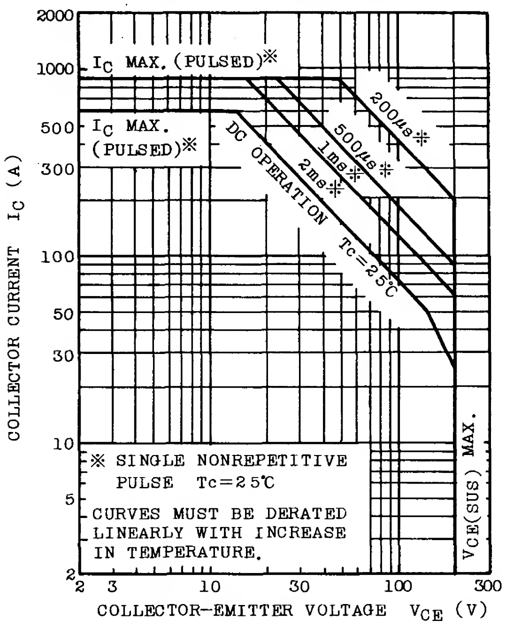
Note : Pulse Test; Pulse Width≦300μs Duty Cycle≦3%
Mounting Force; F=1000kg


VBE(sat) – IC
COMMON EMITTER
IB=4 A
BASE-EMITTER VOLTAGE VBE (V)
3.2
2.8
2.4
2.0
1.6
1.2
Tc=25℃
100
0
200
400
600
800
1000
COLLECTOR CURRENT IC (A)

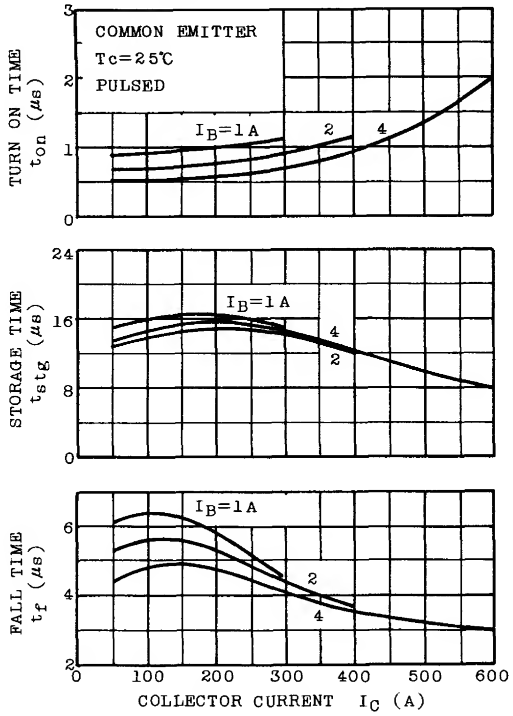

VCE – IC
COMMON EMITTER
Tc=25℃
PULSE WIDTH 50μs
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
IB=1A
2
3
5
10
12
PC=2500W
0
200
400
600
800
1000
COLLECTOR CURRENT IC (A)


VCE – IC
COMMON EMITTER
Tc=100℃
PULSE WIDTH 50μs
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
IB=1A
2
3
5
12
PC=625W
0
200
400
600
800
1000
COLLECTOR CURRENT IC (A)

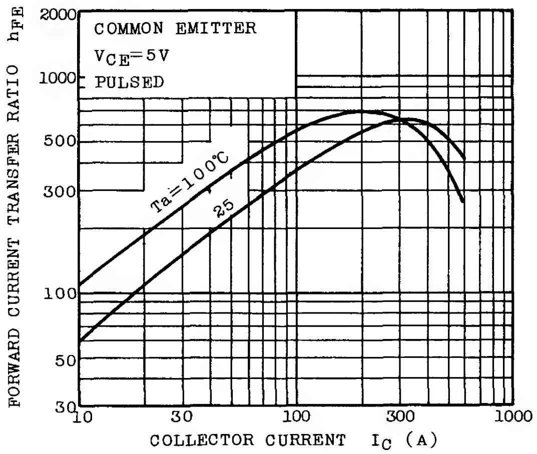
SAFE OPERATING AREA



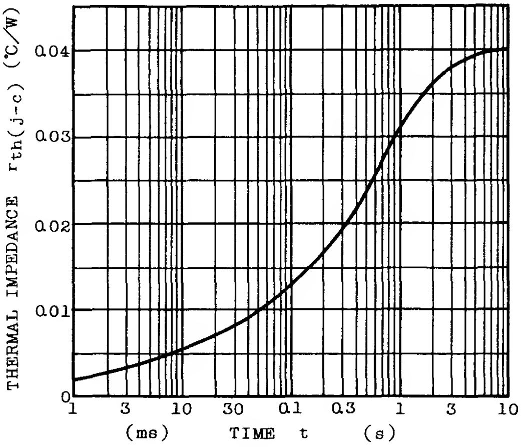
SWITCHING TIME – I_C



h_{FE} – I_C



TRANSIENT THERMAL IMPEDANCE
(JUNCTION TO CASE)



2SD700

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

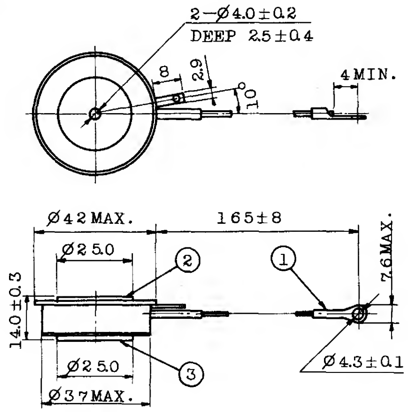
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- High Voltage : $V_{CEO(SUS)}=200V$
- Triple Diffused Design.
- Darlington Design.



1. BASE
2. EMITTER
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2−42A1A

Weight : 70g

MAXIMUM RATINGS (Ta=25°C)

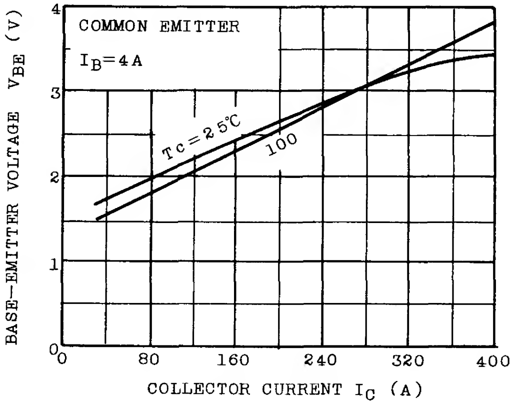
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CBO}	300	V
Collector Emitter Voltage	$V_{CEO(SUS)}$	200	V
Emitter Base Voltage	V_{EBO}	5	V
Collector Current	I_C	200	A
Emitter Current	I_E	-200	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.13	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	-40~150	°C
Mounting Force Required	F	400±40	kg

ELECTRICAL CHARACTERISTICS (Ta=25°C)

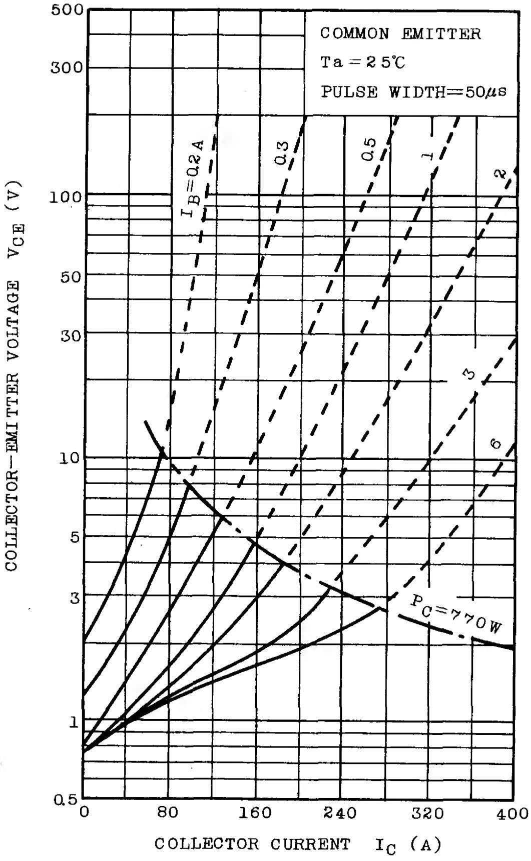
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=200A$	150	-	-	
			$V_{CE}=5V$, $I_C=100A$	-	700	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	200	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=200A$, $I_B=4A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CBO}	$V_{CB}=300V$, $I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	200	mA
Switching Time	Turn-on Time	t_{on}	$I_C=200A$, $I_{B1}=4A$, $-I_{B2}=4A$, $V_C=100V$	-	1.0	-	µs
	Storage Time	t_{stg}		-	4.5	-	µs
	Fall Time	t_f		-	8.0	-	µs

Note : Pulse Test; Pulse Width≦300µs , Duty Cycle≦3%
Mounting Force; F=400kg

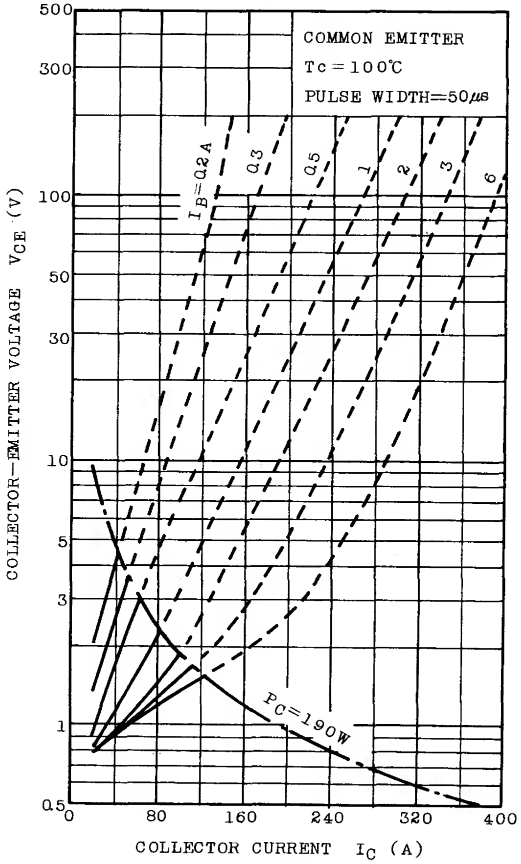
$V_{BE(sat)}$ – I_C



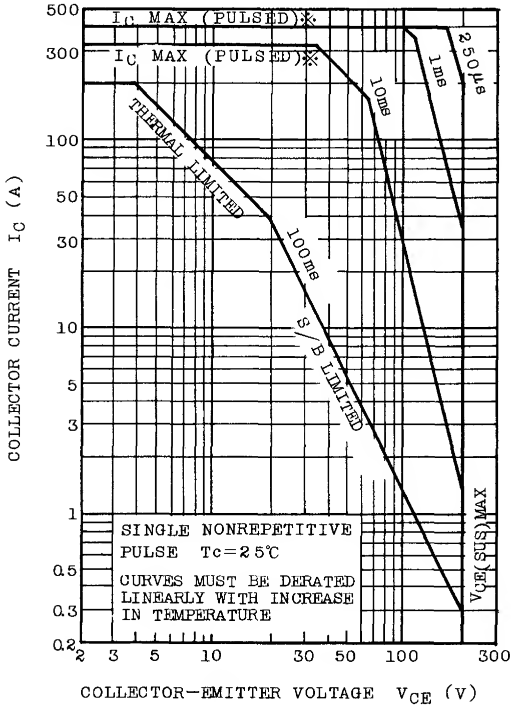
V_{CE} – I_C



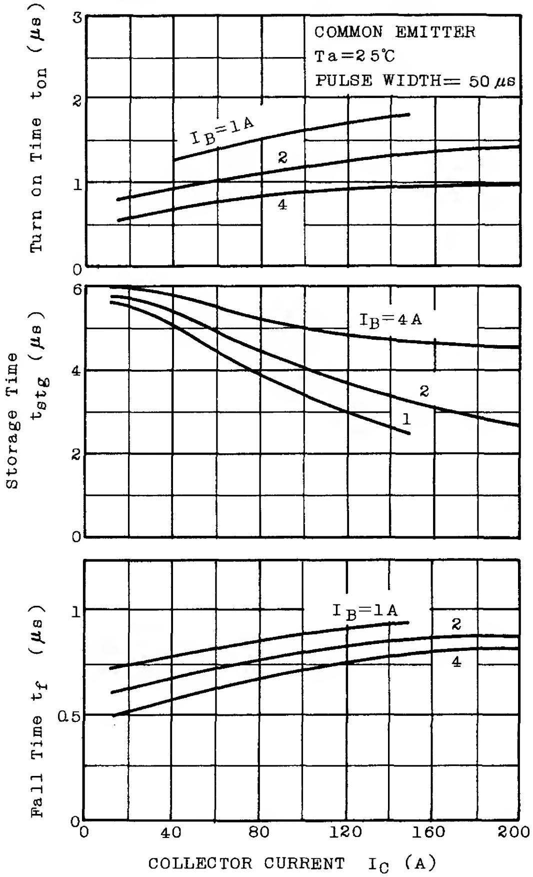
V_{CE} – I_C



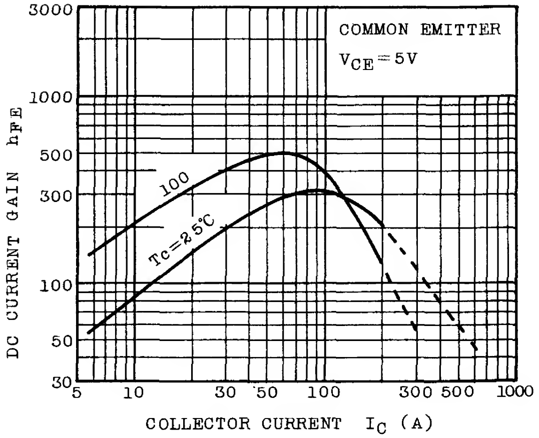
SAFE OPERATING AREA



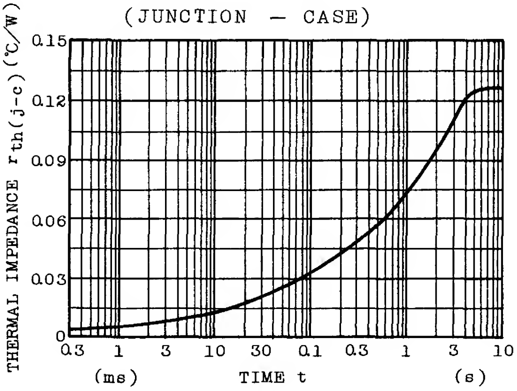
SWITCHING CHARACTERISTICS



h_{FE} – I_C



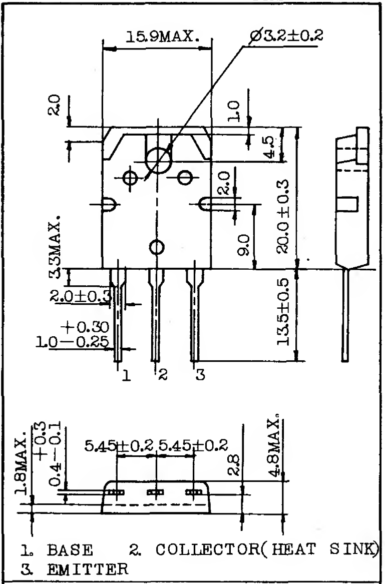
TRANSIENT THERMAL IMPEDANCE
(JUNCTION – CASE)



SILICON NPN TRIPLE DIFFUSED TYPE

2SD716

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB686.
- Recommended for 30 ∿ 35W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

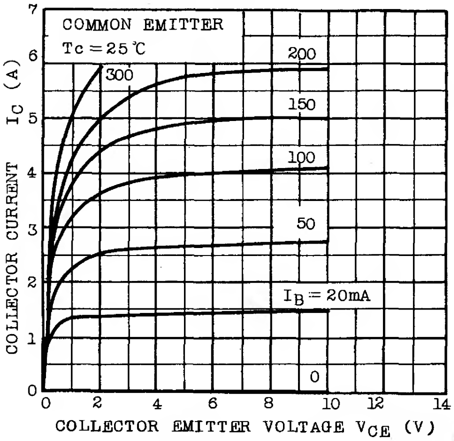
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (Tc=25°C)	P_C	60	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

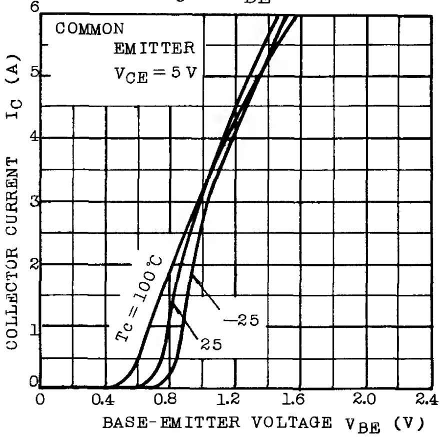
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=1A	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=4A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	12	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	100	-	pF

Note : h_{FE} Classification R : 55∿110, O : 80∿160

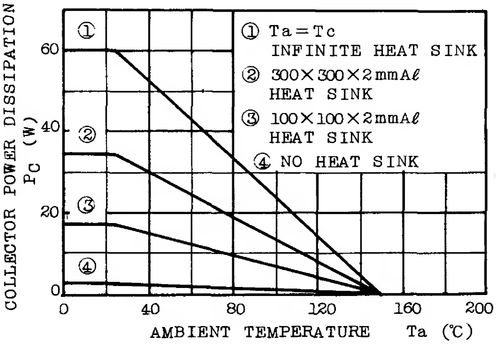
I_C – V_{CE} (LOW VOLTAGE REGION)



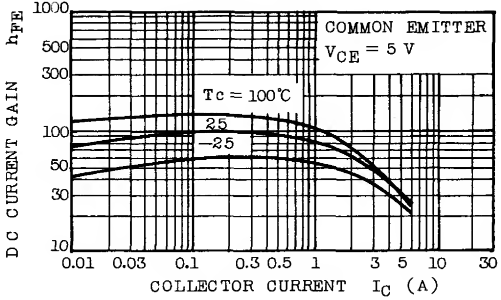
I_C – V_{BE}



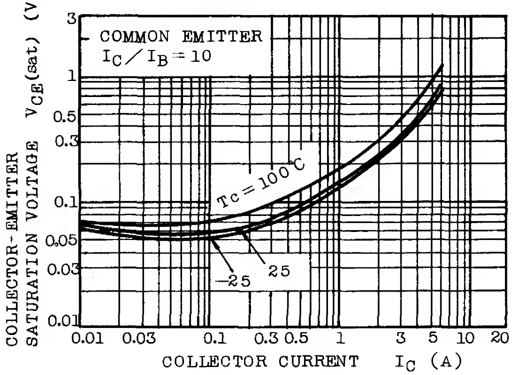
P_C – Ta



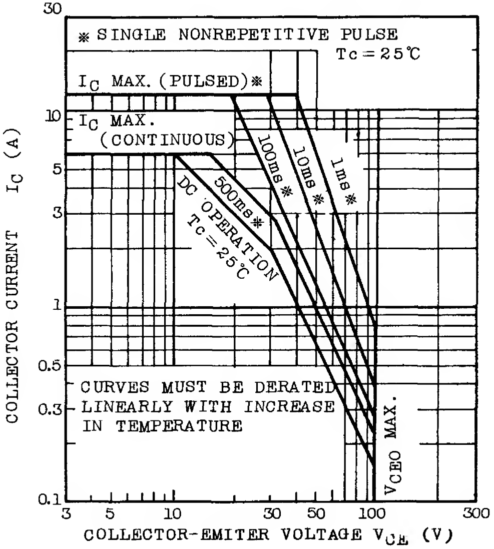
h_{FE} – I_C



$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

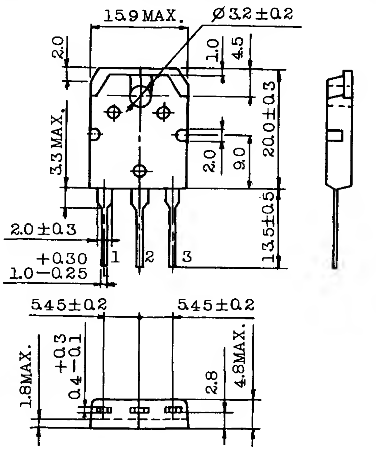
2SD717

HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER AND DC-AC INVERTER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V (Max.), (I_C=6A)
- High Collector Power Dissipation : P_C=80W (Tc=25°C)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

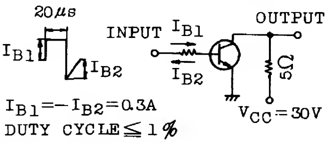
JEDEC	—
EIAJ	—
TOSHIBA	2 — 16B1A

Weight : 4.6 g

MAXIMUM RATINGS (Ta=25°C)

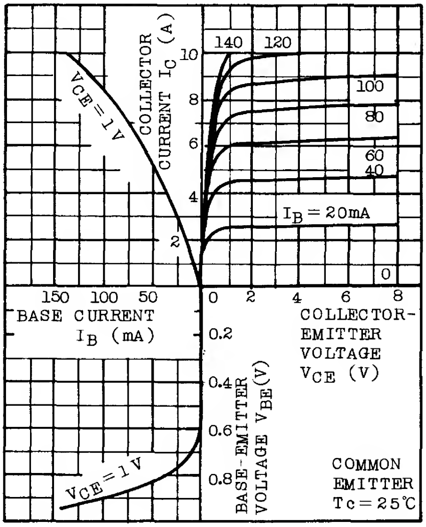
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∼150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

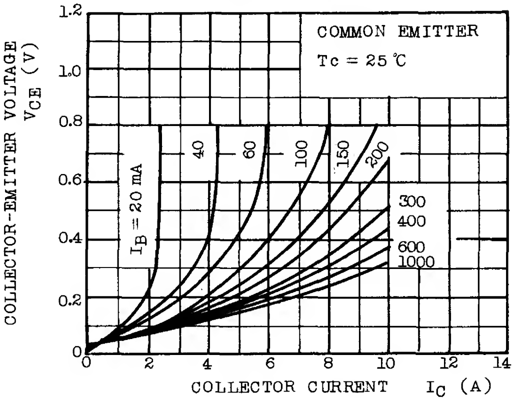
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=70V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=6A	30	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=6A, I_B=0.3A	-	0.25	0.4	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=6A, I_B=0.3A	-	0.9	1.2	V
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	350	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} OUTPUT I_{B1} I_{B2} I_{B2} 5Ω I_{B1}=−I_{B2}=0.3A DUTY CYCLE≦1% V_{CC}=30V	-	0.3	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.4	-	

Note : $h_{FE(1)}$ Classification O : 70∼140, Y : 120∼240

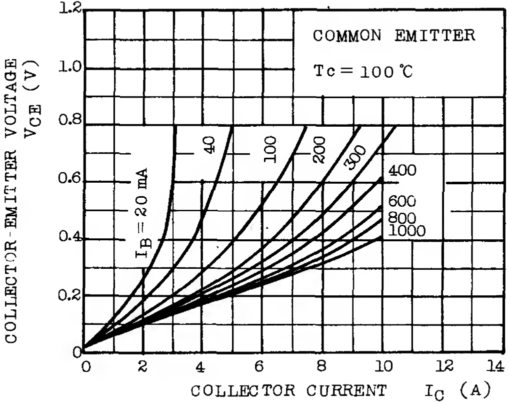
STATIC CHARACTERISTICS



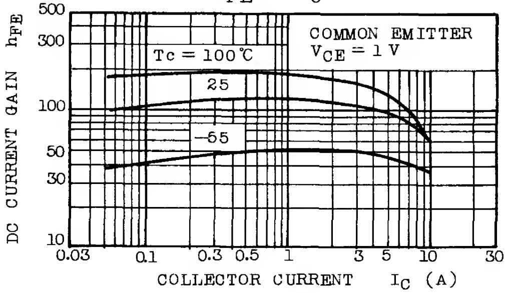
V_{CE} − I_C



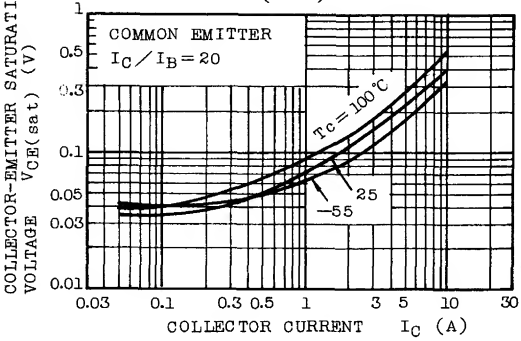
V_{CE} − I_C



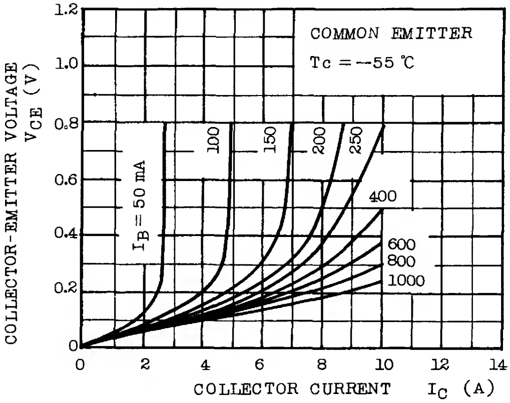
h_{FE} − I_C

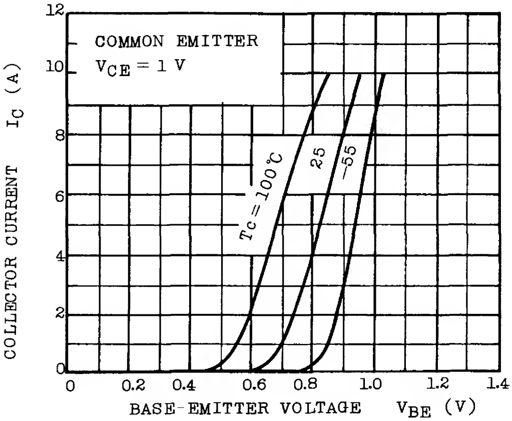


$V_{CE(sat)}$ − I_C

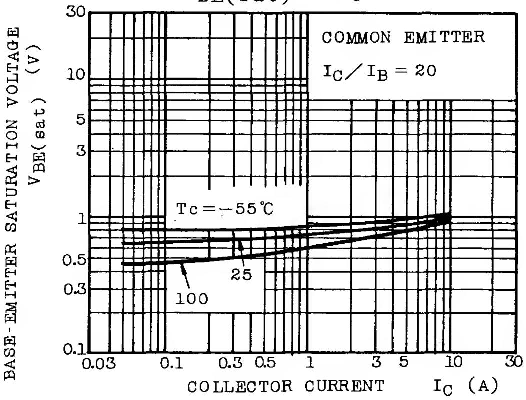


V_{CE} − I_C

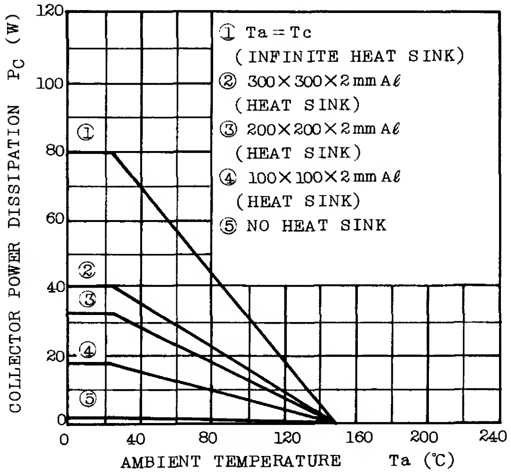




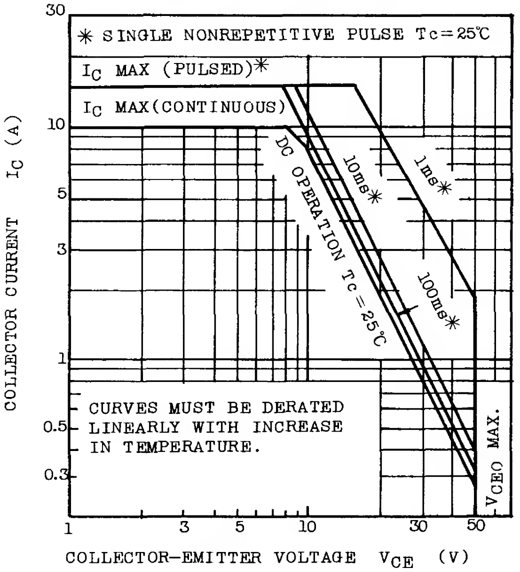
I_C – V_{BE}



$V_{BE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA

2SD718

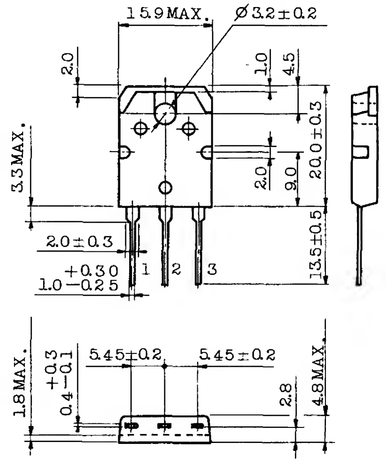
SILICON NPN TRIPLE DIFFUSED TYPE

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB688.
- Recommended for 45 ~ 50W audio frequency amplifier output stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (T_a=25°C)

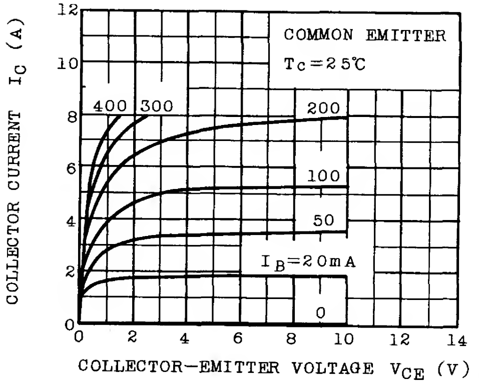
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	120	V
Collector-Emitter Voltage	V_{CEO}	120	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	8	A
Base Current	I_B	0.8	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

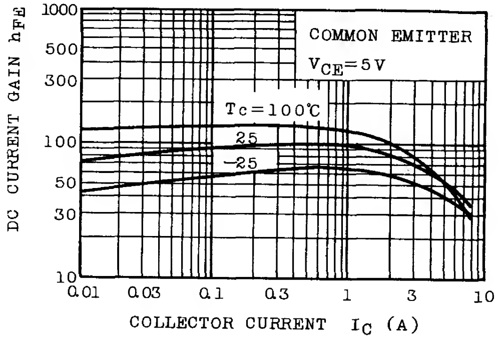
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=120V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	120	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=1A	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	12	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	170	-	pF

Note: h_{FE} Classification R:55~110, O:80~160

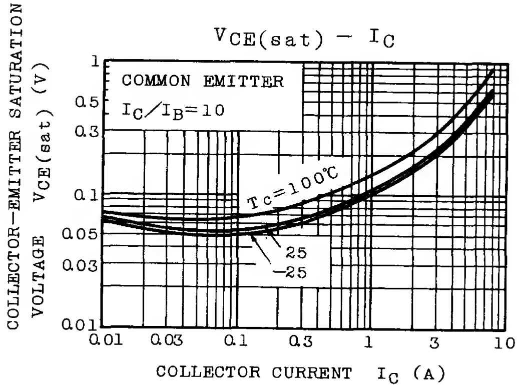
I_C - V_{CE}



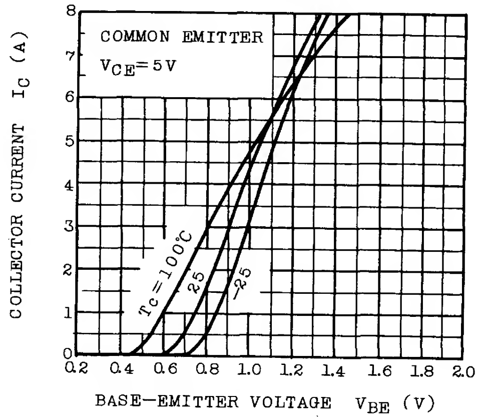
h_{FE} – I_C



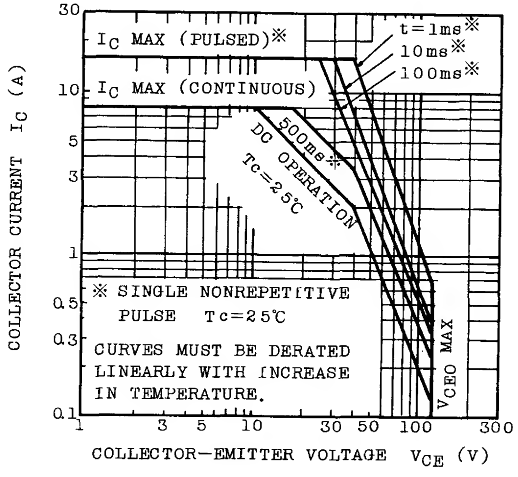
$V_{CE(sat)}$ – I_C



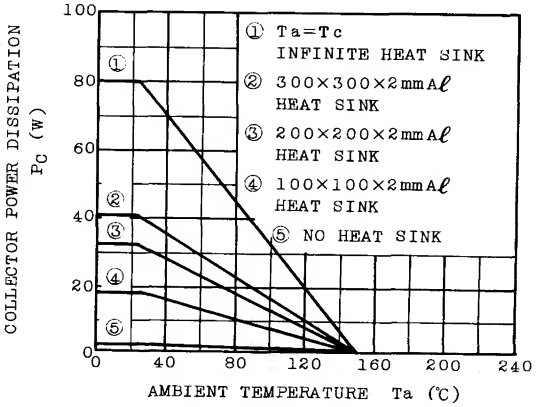
I_C – V_{BE}



SAFE OPERATING AREA



P_C – Tc



2SD777

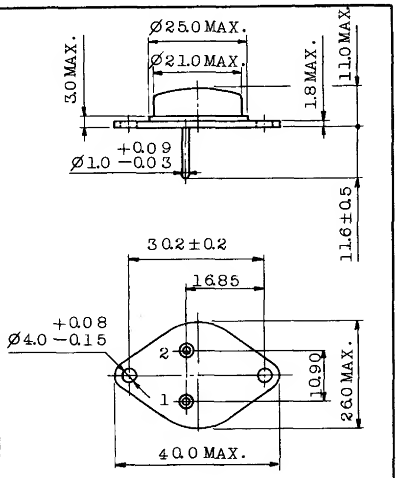
SILICON NPN DOUBLE DIFFUSED TYPE
(PCT PROCESS)

POWER REGULATOR FOR LINE OPERATED
TV APPLICATIONS.

FEATURES:

- Excellent Wide Safe Operating Area (100 W·S at Tc=25°C).
- Included Abalanche Diode. : V_Z=55±10V
- High D.C Current Gain. : $h_{FE} \geq 500$
- High Collector Power Dissipation Capability : 100 W at 25°C Case Temperature.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

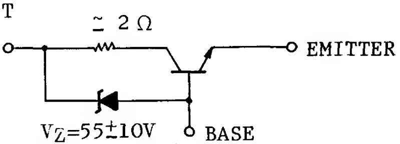
JEDEC	TO−3
EIAJ	TC−3 , TB−3
TOSHIBA	2−21A1A

Mounting kit No. AC73
Weight : 12.0g

MAXIMUM RATINGS (Ta=25°C)

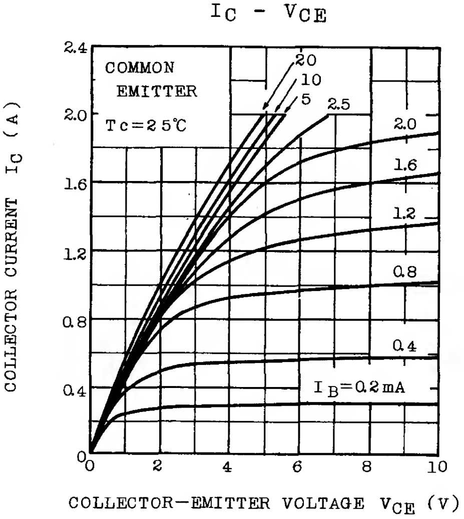
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	55±10	V
Collector-Emitter Voltage	V_{CEO}	55±10	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current (Continuous)	I_C	4	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

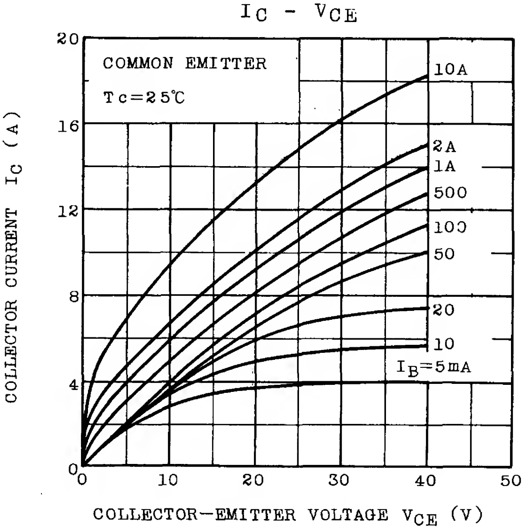
EQUIVALENT CIRCUIT

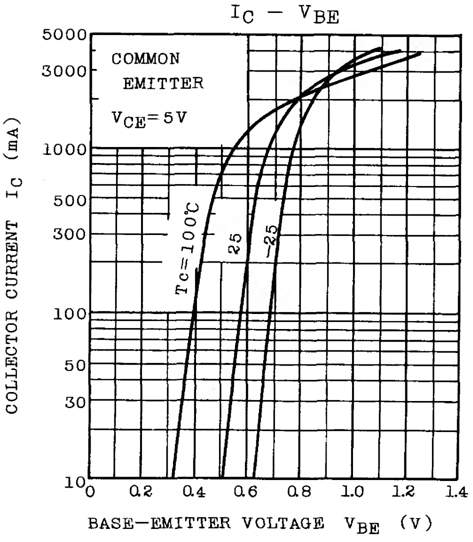


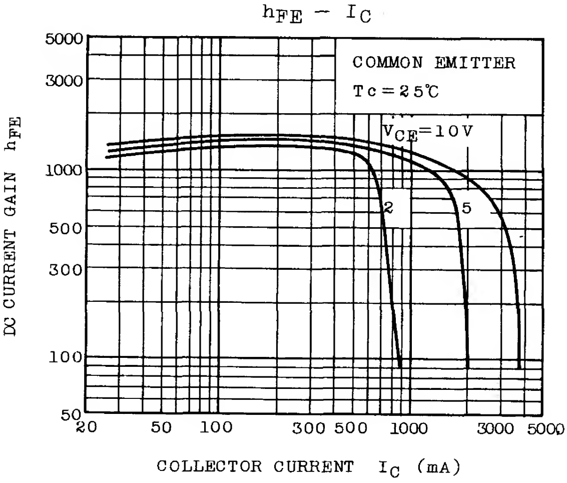
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	45	55	65	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	45	55	65	V
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	−	−	10	μA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=500mA	500	1000	2500	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (1)	I_C=500mA, I_B=2mA	−	−	2.0	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (2)	I_C=1.0A, I_B=20mA	1.0	2.0	3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=500mA	0.50	0.65	0.80	V
Allowable Energy (Tc=25°C)	E_T	Application Circuit	100	−	−	W·sec

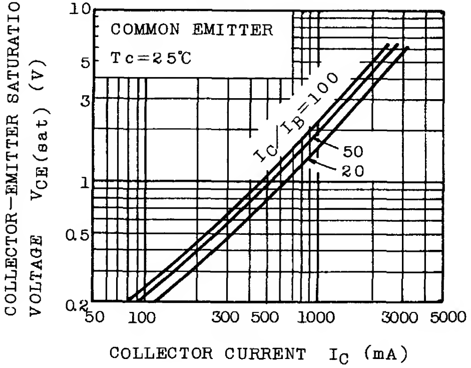

IC - VCE
COMMON EMITTER
Tc=25℃
20
10
5
2.5
2.0
1.6
1.2
0.8
0.4
IB=0.2mA
COLLECTOR CURRENT IC (A)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
2
4
6
8
10
COLLECTOR—EMITTER VOLTAGE VCE (V)


IC - VCE
COMMON EMITTER
Tc=25℃
10A
2A
1A
500
100
50
20
10
IB=5mA
COLLECTOR CURRENT IC (A)
20
16
12
8
4
0
0
10
20
30
40
50
COLLECTOR—EMITTER VOLTAGE VCE (V)

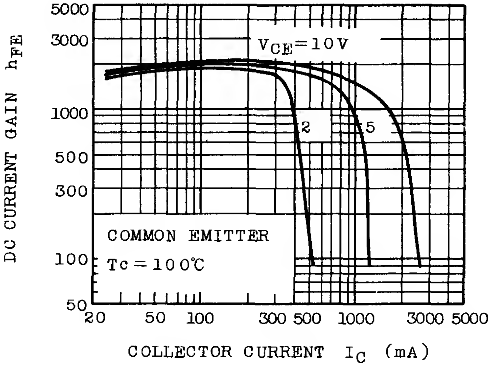

IC — VBE
COMMON EMITTER
VCE=5V
Tc=100℃
25
-25
COLLECTOR CURRENT IC (mA)
5000
3000
1000
500
300
100
50
30
10
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE—EMITTER VOLTAGE VBE (V)


hFE — IC
COMMON EMITTER
Tc=25℃
VCE=10V
2
5
DC CURRENT GAIN hFE
5000
3000
1000
500
300
100
50
20
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT IC (mA)

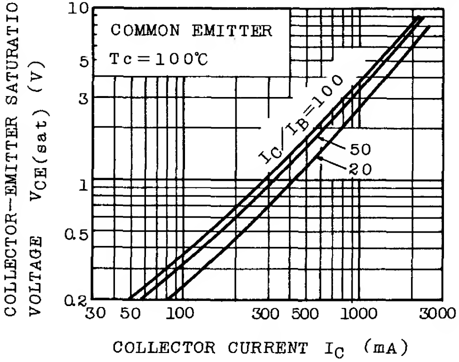
$V_{CE(sat)} - I_C$



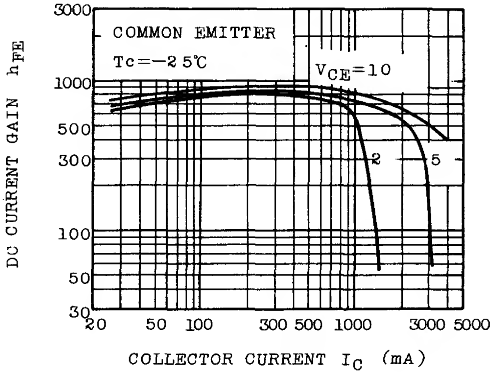
$h_{FE} - I_C$



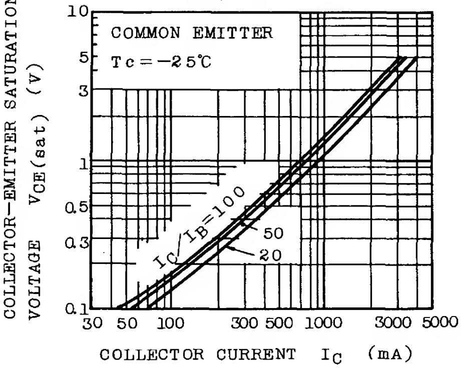
$V_{CE(sat)} - I_C$



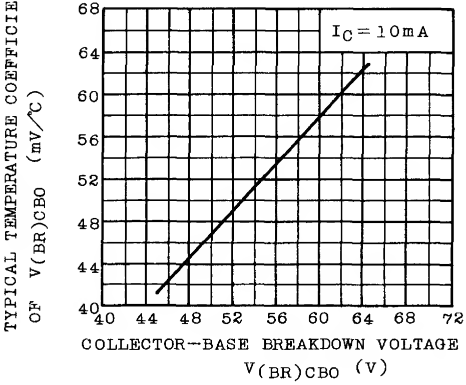
$h_{FE} - I_C$

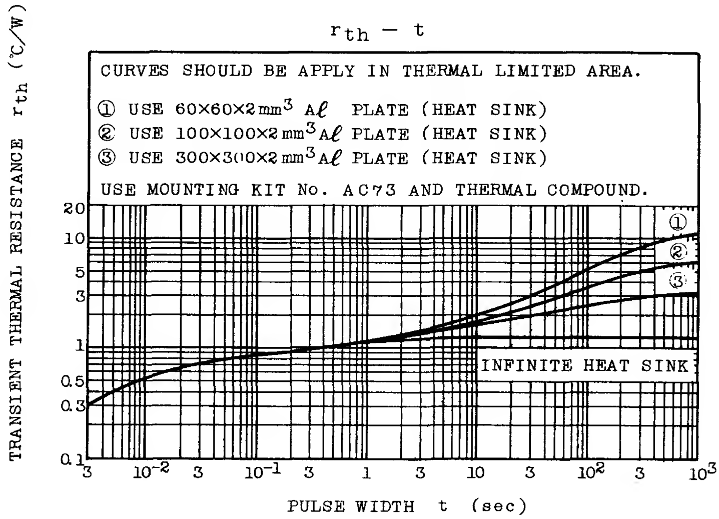


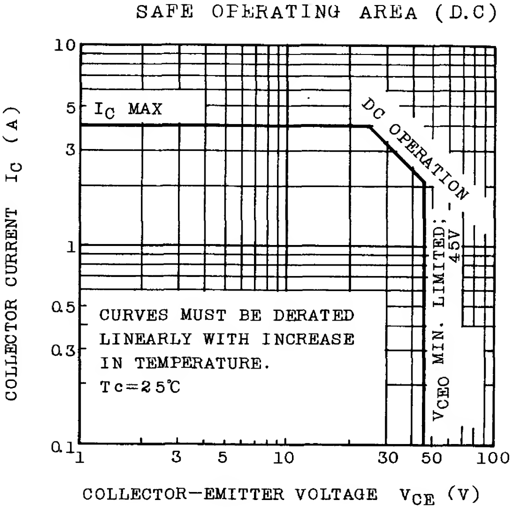
$V_{CE(sat)} - I_C$

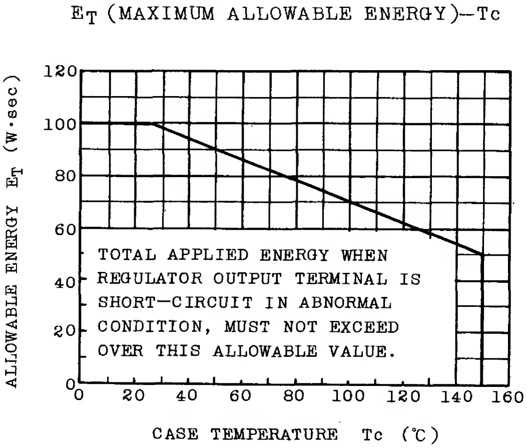


TYPICAL TEMPERATURE COEFFICIENT OF $V_{(BR)CBO}$

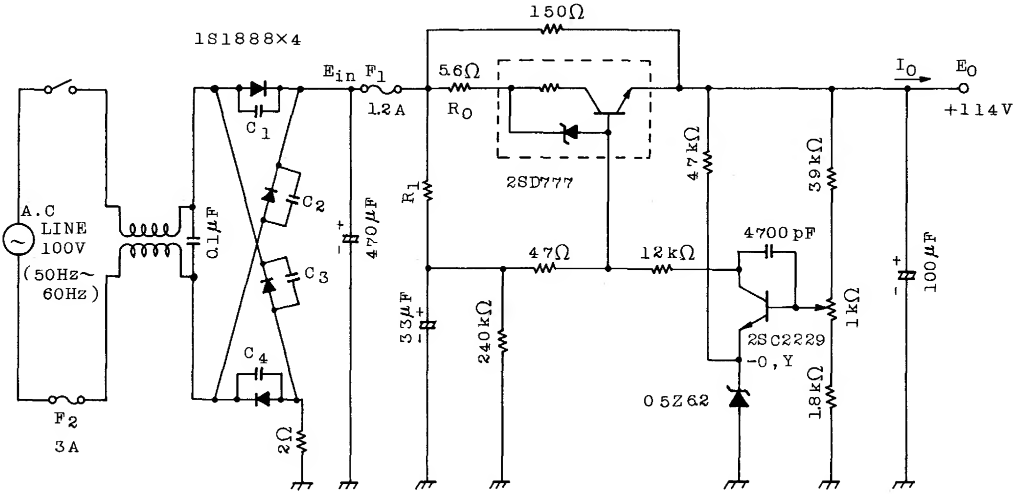



r_{th} — t
CURVES SHOULD BE APPLY IN THERMAL LIMITED AREA.
① USE 60×60×2mm³ Aℓ PLATE (HEAT SINK)
② USE 100×100×2mm³ Aℓ PLATE (HEAT SINK)
③ USE 300×300×2mm³ Aℓ PLATE (HEAT SINK)
USE MOUNTING KIT No. AC73 AND THERMAL COMPOUND.
①
②
③
INFINITE HEAT SINK
TRANSIENT THERMAL RESISTANCE r_{th} (℃/W)
20
10
5
3
1
0.5
0.3
0.1
3
10⁻²
3
10⁻¹
3
1
3
10
3
10²
3
10³
PULSE WIDTH t (sec)


SAFE OPERATING AREA (D.C)
I_C MAX
DC OPERATION
V_{CEO} MIN. LIMITED; 45V
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
Tc=25℃
COLLECTOR CURRENT I_C (A)
10
5
3
1
0.5
0.3
0.1
1
3
5
10
30
50
100
COLLECTOR—EMITTER VOLTAGE V_{CE} (V)

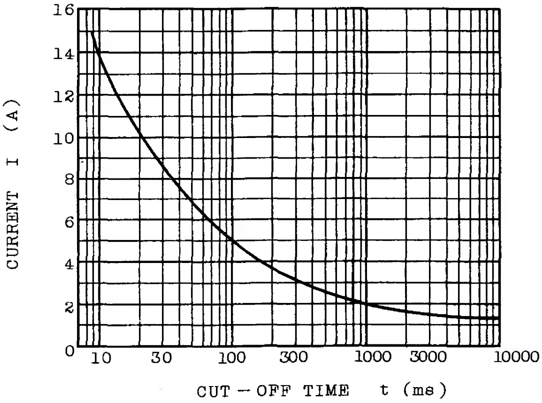

E_T (MAXIMUM ALLOWABLE ENERGY)—Tc
TOTAL APPLIED ENERGY WHEN REGULATOR OUTPUT TERMINAL IS SHORT—CIRCUIT IN ABNORMAL CONDITION, MUST NOT EXCEED OVER THIS ALLOWABLE VALUE.
ALLOWABLE ENERGY E_T (W·sec)
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
CASE TEMPERATURE Tc (℃)

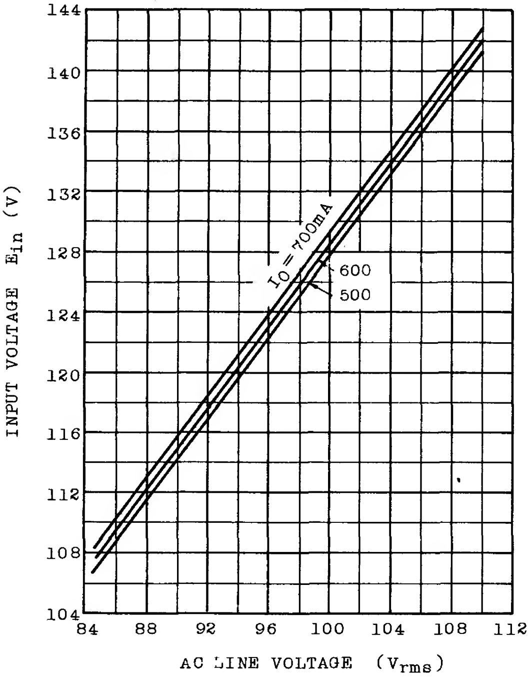
APPLICATION CIRCUIT

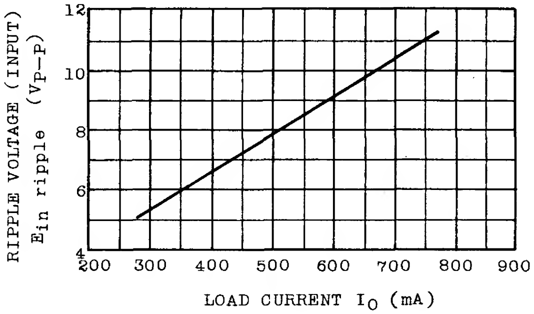


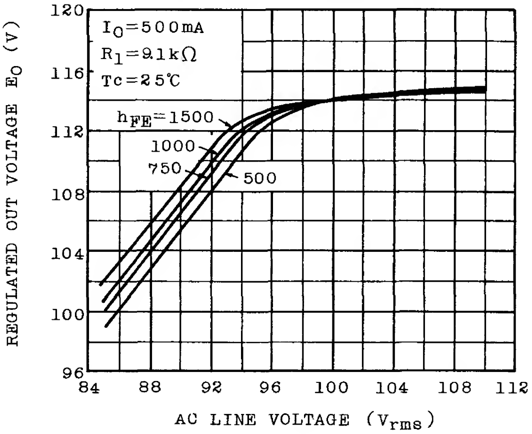
C1, C2, C3, C4 : 0.0047μF

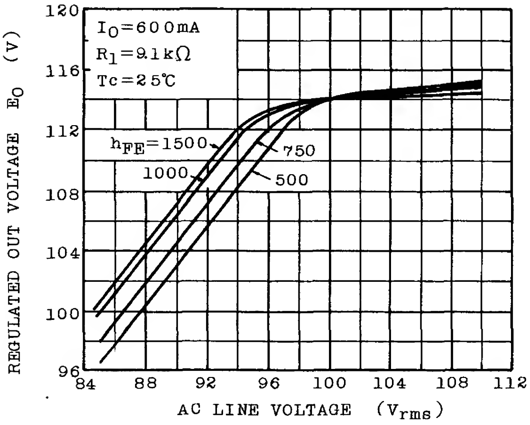
FUSE F1 ; I−t CHARACTERISTIC

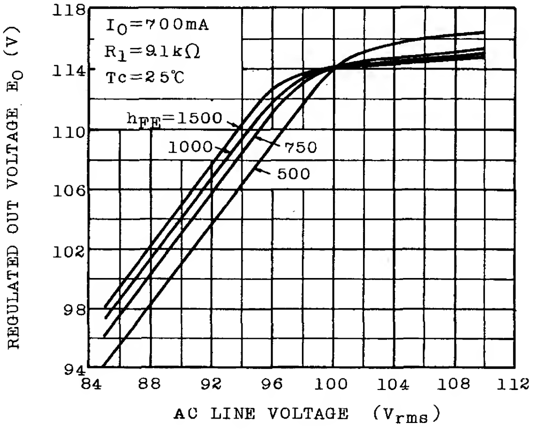



AC LINE VOLTAGE — E_{in}


I_O — E_{in} ripple


AC LINE VOLTAGE — E_O


AC LINE VOLTAGE — E_O


AC LINE VOLTAGE — E_O

2SD797

SILICON NPN TRIPLE DIFFUSED TYPE

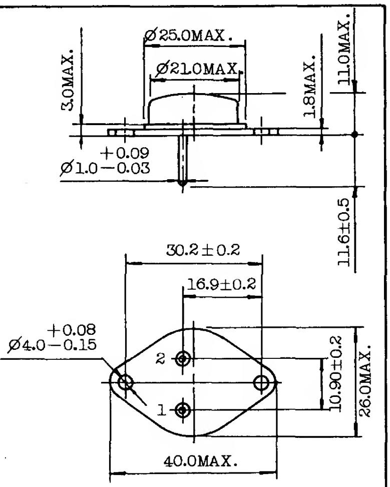
INDUSTRIAL APPLICATIONS

HGIH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=200W (Tc=25°C)
- High Collector Current : I_C=30A

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

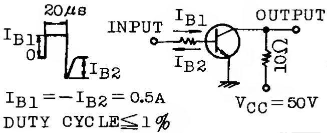
JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21A1A

Mounting Kit No. AC73
Weight : 12.9g

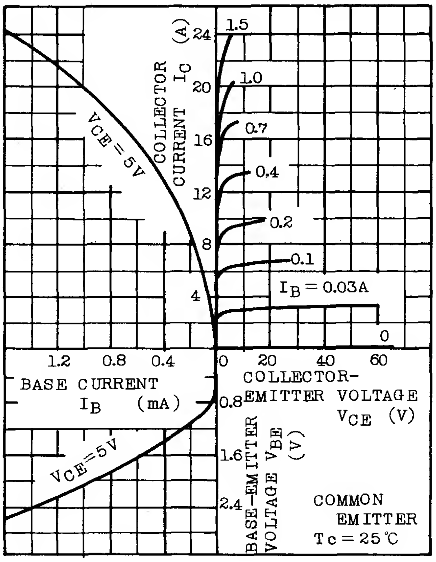
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	30	A
Base Current	I_B	8	A
Collector Power Dissipation (Tc=25°C)	P_C	200	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65∿175	°C

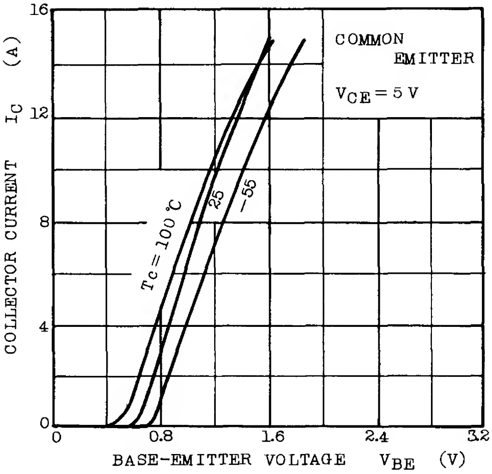
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	60	-	200	
		$h_{FE(2)}$	V_{CE}=5V, I_C=15A	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=15A, I_B=3A	-	0.6	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	1.4	2.5	V
Transition Frequency		f_T	V_{CE}=5V, I_C=1A	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs IB1 0 IB2 INPUT IB1 IB2 OUTPUT 10Ω VCC=50V IB1=−IB2=0.5A DUTY CYCLE≦1%	-	2.5	-	μs
	Storage Time	t_{stg}		-	6	-	
	Fall Time	t_f		-	1.5	-	

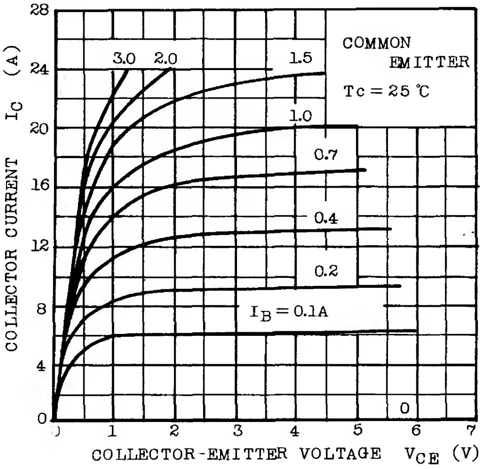
STATIC CHARACTERISTICS



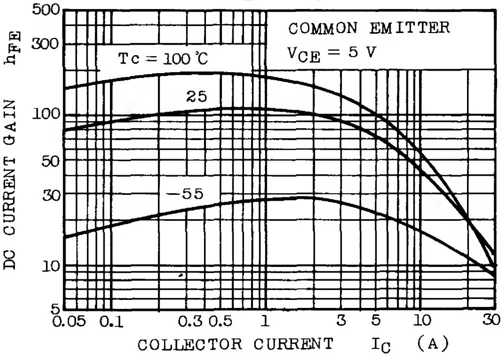
IC – VBE



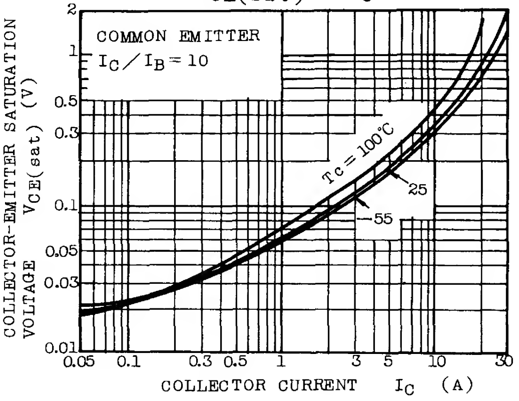
IC – VCE (LOW VOLTAGE REGION)

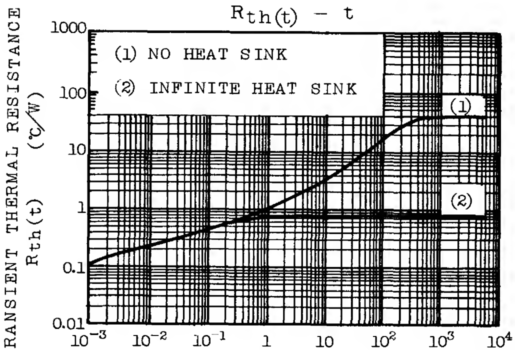


hFE – IC

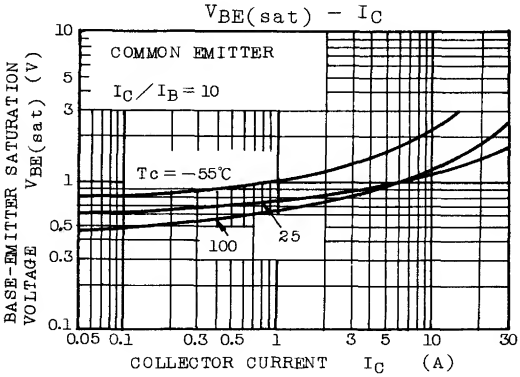


VCE(sat) – IC

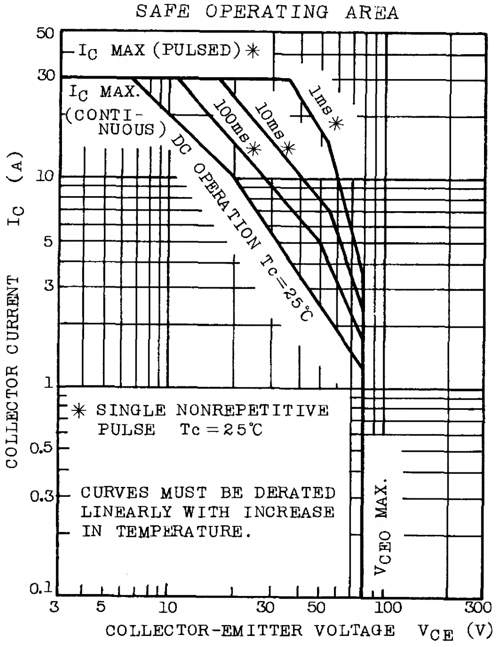




Rth(t) – t



VBE(sat) – IC



SAFE OPERATING AREA

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD798

INDUSTRIAL APPLICATIONS.

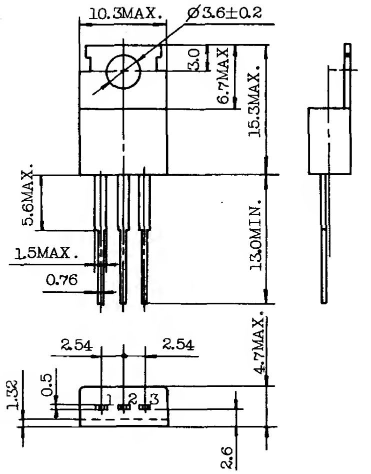
IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=1500 (Min.)(V_{CE}=2V, I_C=2A)

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

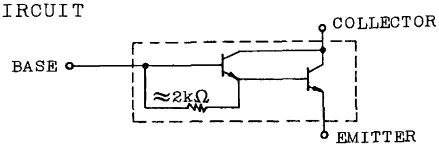
JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 — 10A1A

Mounting Kit No. AC75
Weight : 1.9g

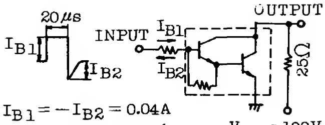
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

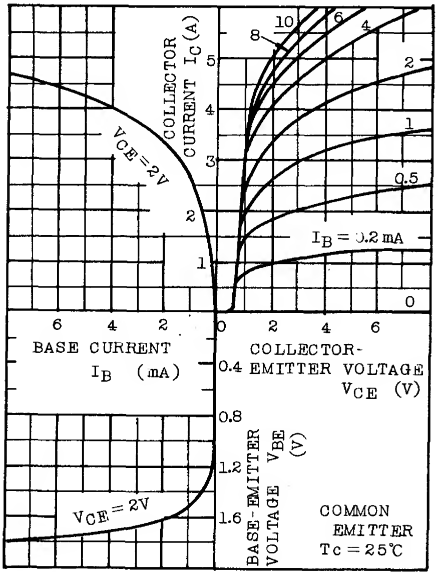
EQUIVALENT CIRCUIT



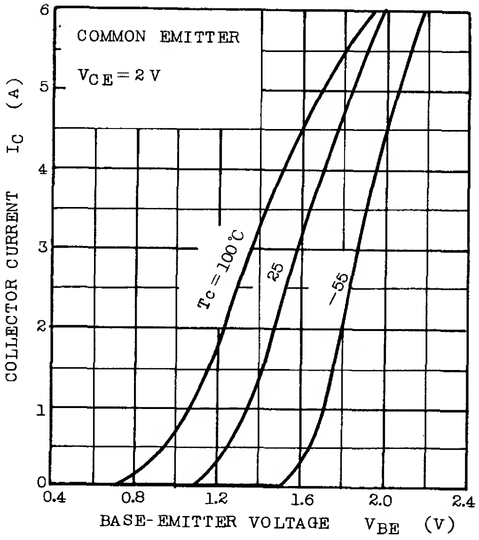
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	300	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	1500	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f	$I_{B1}=-I_{B2}$=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	5	-	

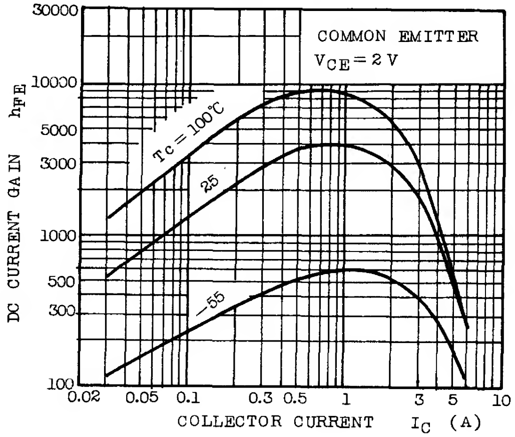
STATIC CHARACTERISTICS



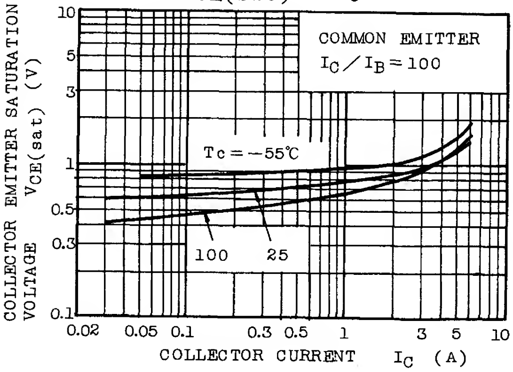
I_C − V_{BE}



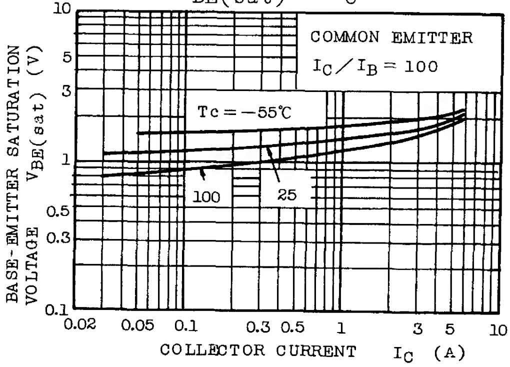
h_{FE} − I_C

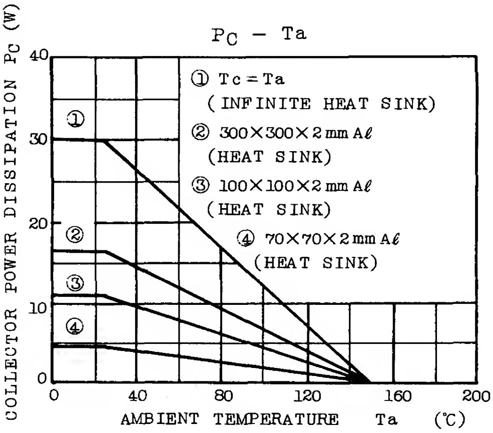


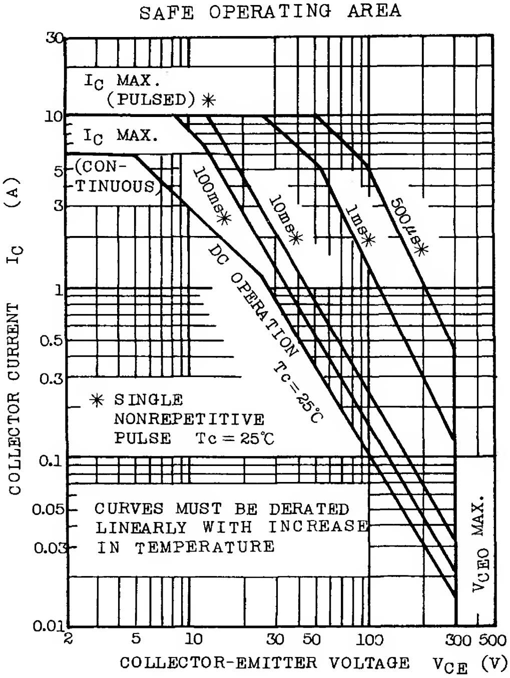
$V_{CE(sat)}$ − I_C



$V_{BE(sat)}$ − I_C




PC – Ta
COLLECTOR POWER DISSIPATION PC (W)
40
30
20
10
0
0
40
80
120
160
200
AMBIENT TEMPERATURE Ta (℃)
①
②
③
④
① Tc = Ta
(INFINITE HEAT SINK)
② 300×300×2 mm Aℓ
(HEAT SINK)
③ 100×100×2 mm Aℓ
(HEAT SINK)
④ 70×70×2 mm Aℓ
(HEAT SINK)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
2
5
10
30
50
100
300
500
COLLECTOR-EMITTER VOLTAGE VCE (V)
IC MAX.
(PULSED) ✳
IC MAX.
(CON-
TINUOUS)
100ms✳
10ms✳
1ms✳
500μs✳
DC OPERATION
Tc = 25℃
✳ SINGLE
NONREPETITIVE
PULSE Tc = 25℃
CURVES MUST BE DERATED
LINEARLY WITH INCREASE
IN TEMPERATURE
VCEO MAX.

2SD799

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

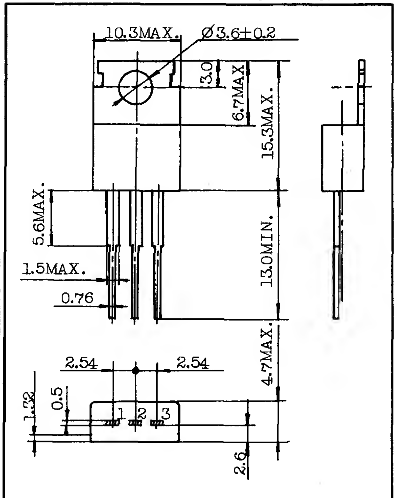
HIGH VOLTAGE SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

FEATURES:

- High DC Current Gain : h_{FE}=600(Min.)(V_{CE}=2V,I_C=2A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO – 220AB
EIAJ	SC – 46
TOSHIBA	2 – 10A1A

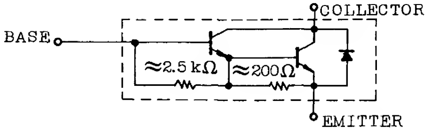
Mounting Kit No. AC75

Weight : 1.9g

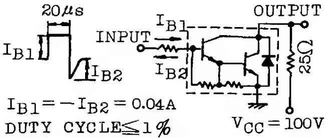
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

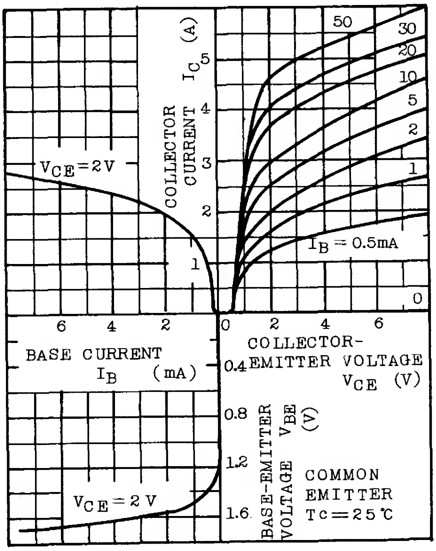
EQUIVALENT CIRCUIT



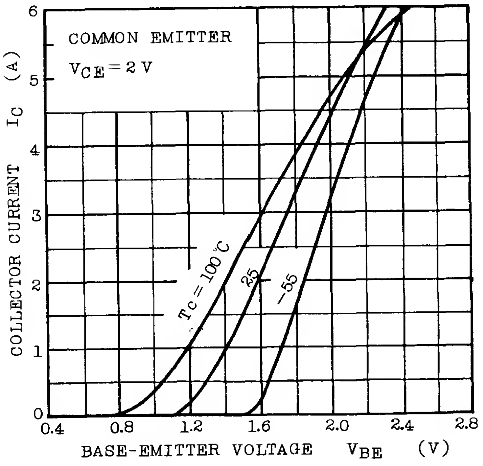
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	–	–	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	–	–	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	–	–	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	600	–	–	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	100	–	–	
Collector-Emitter Saturaton Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	–	–	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	–	–	2.5	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=4A, I_B=0	–	–	3.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V,I_E=0,f=1MHz	–	35	–	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT IB1 IB2 25Ω IB1 = –IB2 = 0.04A DUTY CYCLE≦1% VCC = 100V	–	1	–	μs
	Storage Time	t_{stg}		–	8	–	
	Fall Time	t_f		–	5	–	

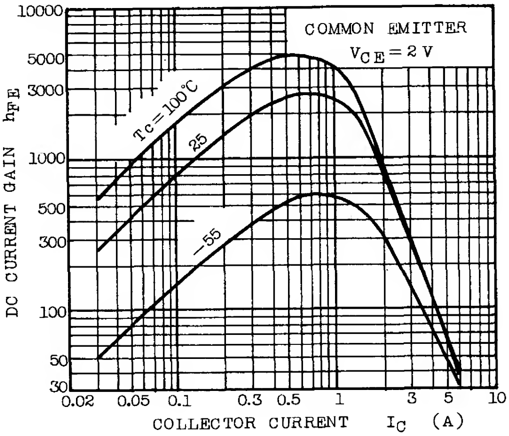
STATIC CHARACTERISTICS



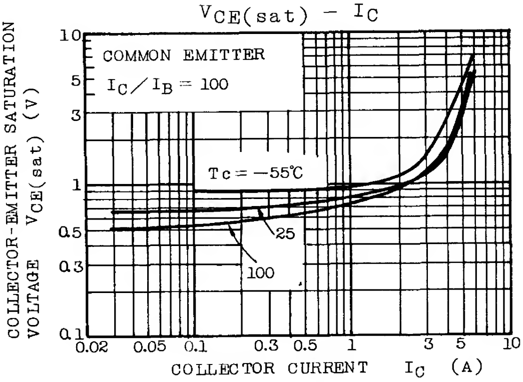
I_C – V_{BE}



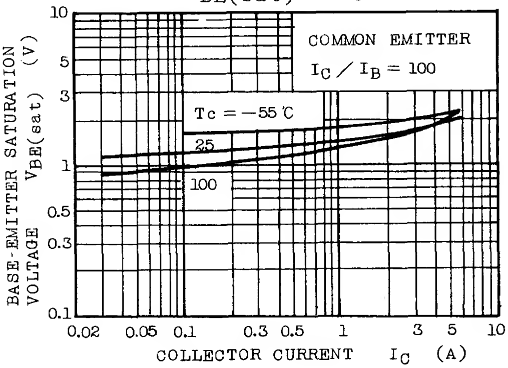
h_{FE} – I_C

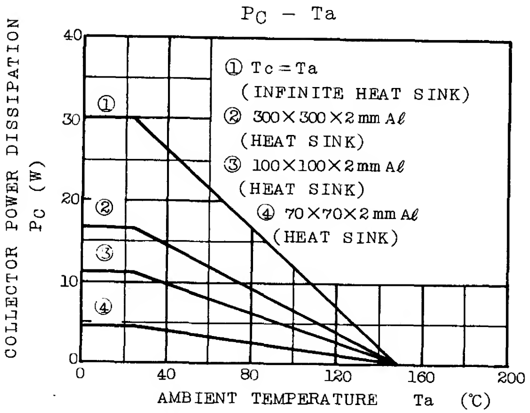


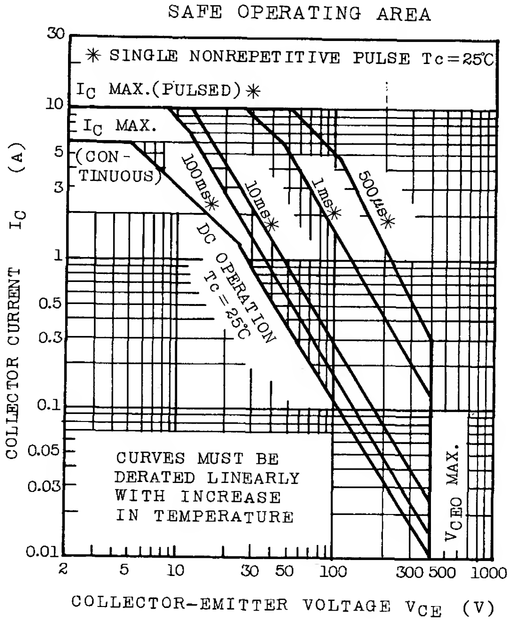
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C




P_C − Ta
COLLECTOR POWER DISSIPATION P_C (W)
40
30
20
10
0
① Tc = Ta (INFINITE HEAT SINK)
② 300×300×2 mm Aℓ (HEAT SINK)
③ 100×100×2 mm Aℓ (HEAT SINK)
④ 70×70×2 mm Aℓ (HEAT SINK)
①
②
③
④
0
40
80
120
160
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
✳ SINGLE NONREPETITIVE PULSE Tc=25℃
I_C MAX.(PULSED) ✳
I_C MAX.
(CON-TINUOUS)
100ms✳
10ms✳
1ms✳
500μs✳
DC OPERATION Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
2
5
10
30
50
100
300
500
1000
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

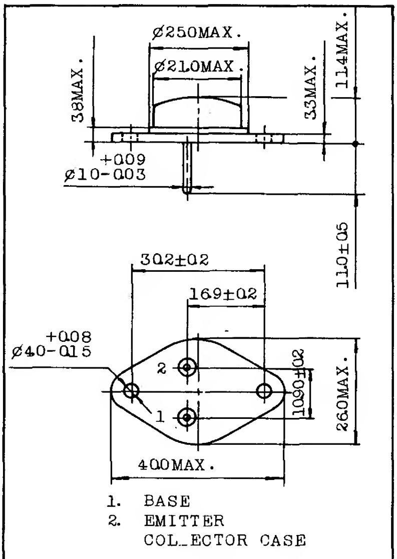
2SD811

HIGH POWER SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=900V
- High Peak Current Capability : $I_{C(Peak)}$=10A
- High Speed Switching : t_f=0.5μs (Max.)

Unit in mm



JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

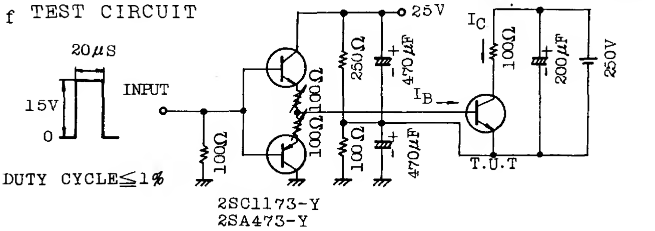
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	900	V
Collector-Emitter Voltage	V_{CEO}	400	V
Collector-Base Voltage	V_{EBO}	7	V
Collector Current (DC)	I_C	6	A
Peak Collector Current	$I_{c\ peak}$	10	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Tempeature Range	T_{stg}	-65∿150	°C

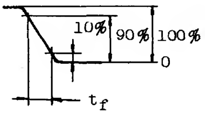
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=900V, I_E=0	-	-	1	mA
Emitter Cut-off Current	I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
DC Current Gain	$h_{FE(1)}$	V_{CE}=5V, I_C=10mA	8	-	-	
	$h_{FE(2)}$	V_{CE}=5V, I_C=0.6A	10	-	40	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2.5A, I_B=0.5A	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2.5A, I_B=0.5A	-	-	1.5	V
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	75	-	pF
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	5	-	MHz
Fall Time	t_f	I_C=2.5A, I_{B1}=0.5A I_{B2}=-1A (Fig.)	-	-	0.5	μs

Fig. t_f TEST CIRCUIT

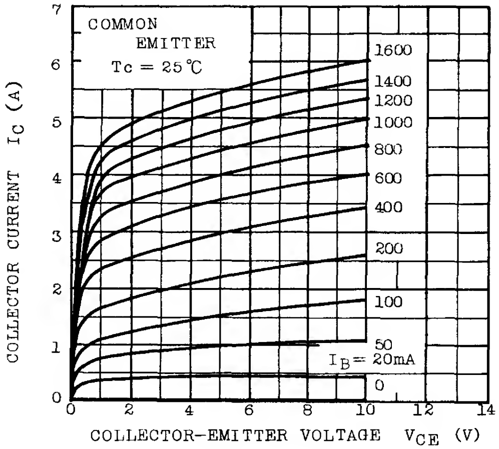


COLLECTOR CURRENT WAVEFORM

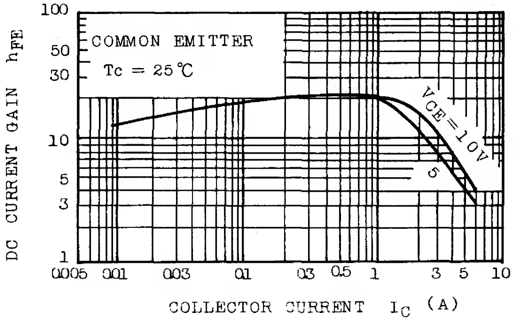


2SD811

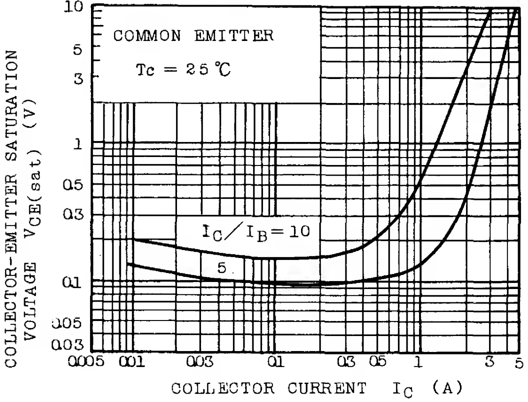
I_C — V_{CE}



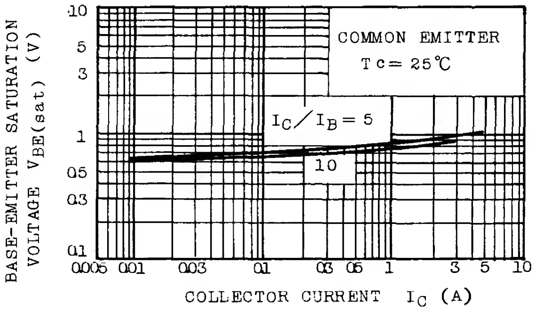
h_{FE} - I_C



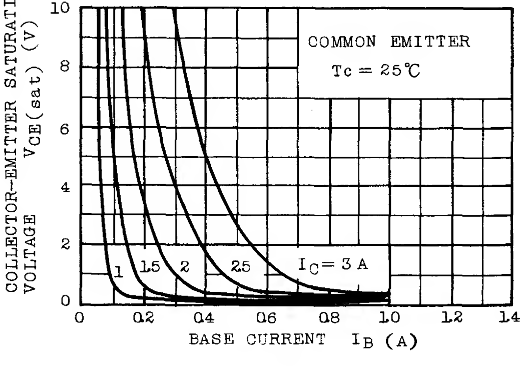
$V_{CE(sat)}$ — I_C



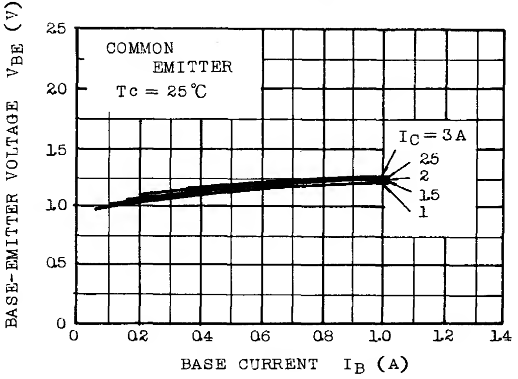
$V_{BE(sat)}$ - I_C



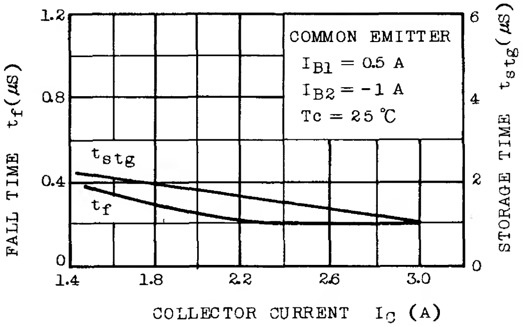
$V_{CE(sat)}$ — I_B



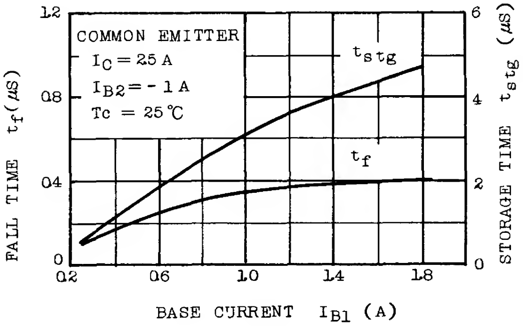
V_{BE} - I_B



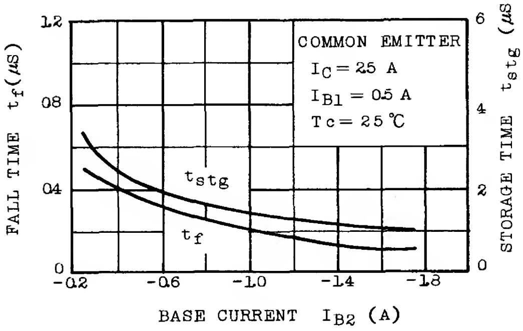
SWITCHING CHARACTERISTICS



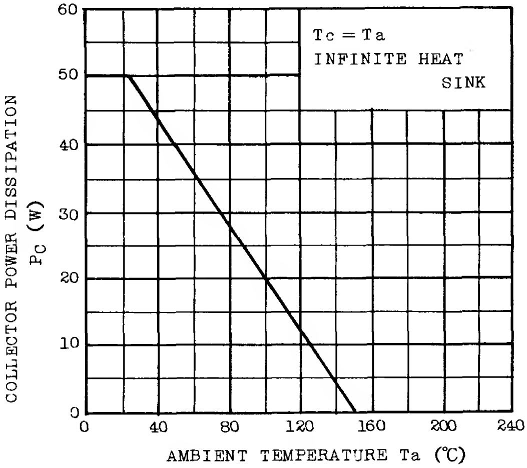
SWITCHING CHARACTERISTICS



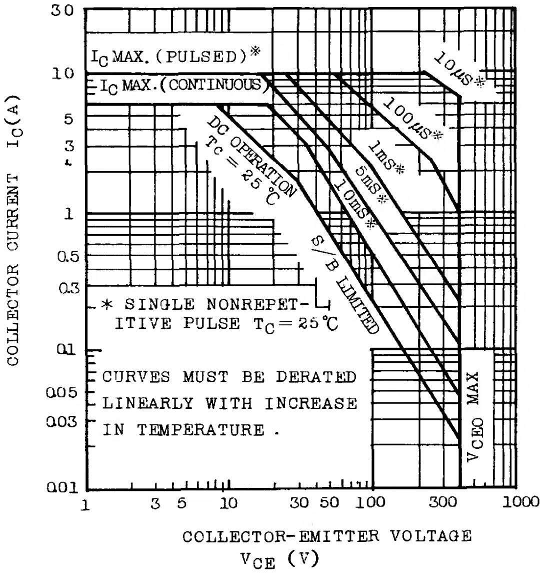
SWITCHING CHARACTERISTICS



P_C - Ta



SAFE OPERATING AREA



2SD818

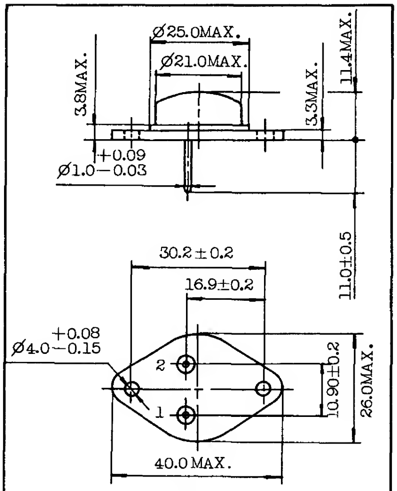
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=4V (Typ.)
- High speed : t_f=0.5μs (Typ.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO — 3
EIAJ	TC — 3, TB — 3
TOSHIBA	2 — 21B1A

Mounting kit No. AC42C
Weight : 17g

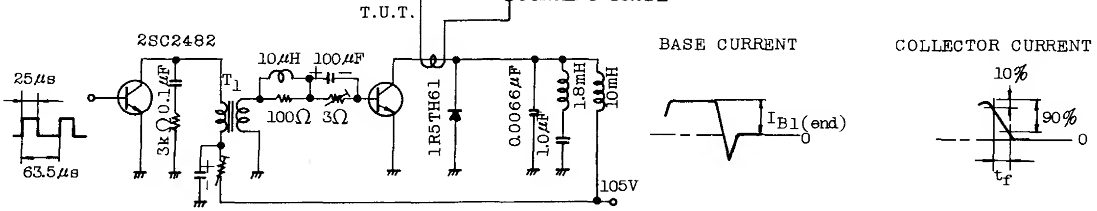
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CBO}	1500	V
Collector Emitter Voltage	V_{CEO}	600	V
Emitter Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

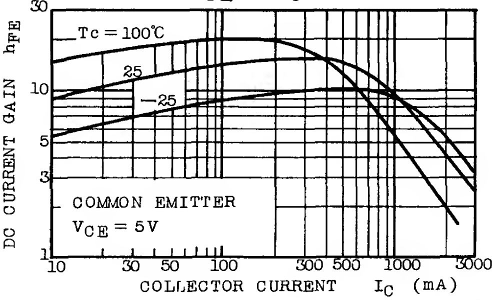
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2.0A, I_B=0.6A	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2.0A, I_B=0.6A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time	t_f	I_{CP}=2.0A, $I_{B1(end)}$=0.6A(Fig.)	-	0.5	1.0	μs

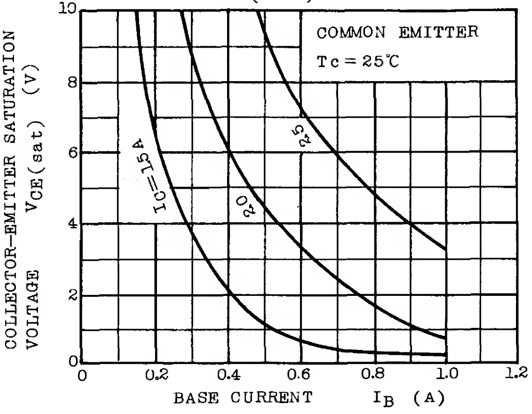
Fig. t_f TEST CIRCUIT



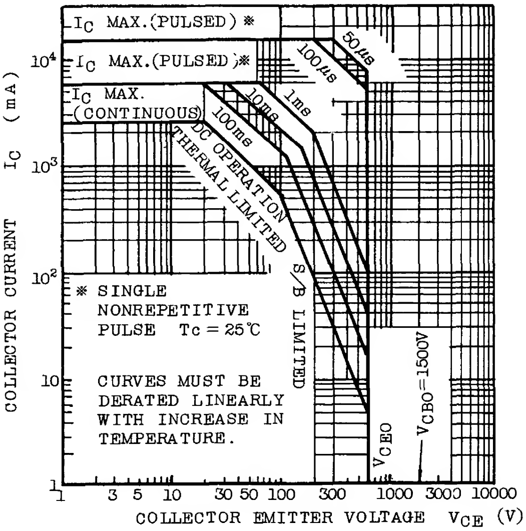
h_{FE} – I_C



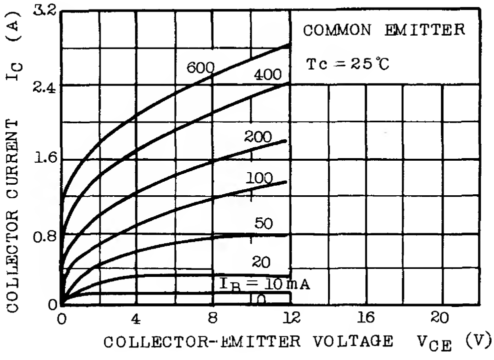
$V_{CE(sat)}$ – I_B



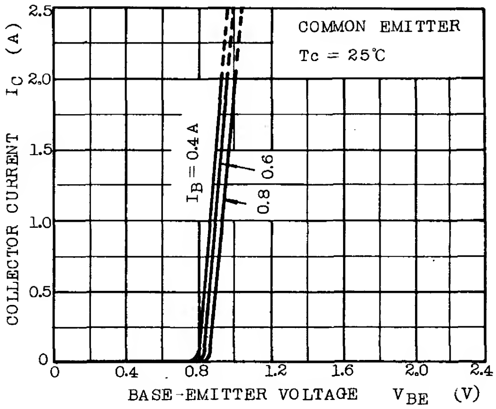
SAFE OPERATING AREA



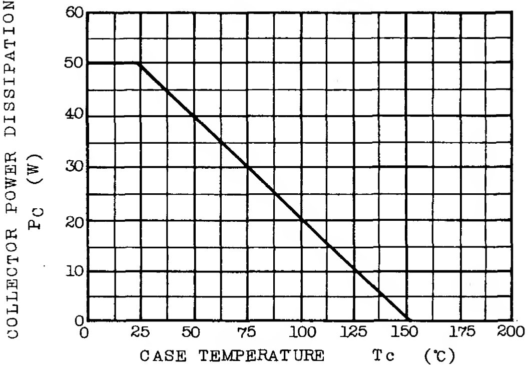
I_C – V_{CE}



I_C – V_{BE}



P_C – T_C



2SD819

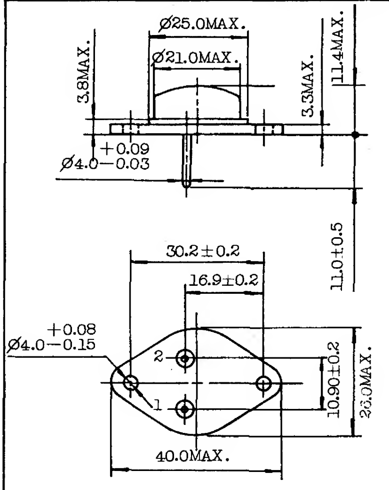
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=4V (Typ.) (I_C=3A, I_B=0.8A)
- High Speed : t_f =1.0μs (Max.) (I_{CP}=3A, $I_{B1(end)}$=0.8A)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21B1A

Mounting kit No. AC42C
Weight : 17g

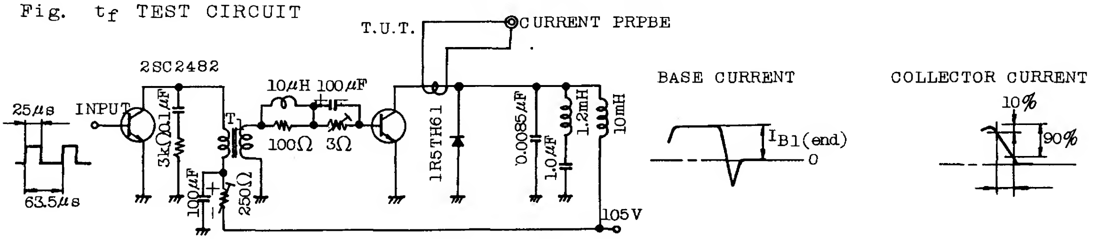
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTICS	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CBO}	1500	V
Collector Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

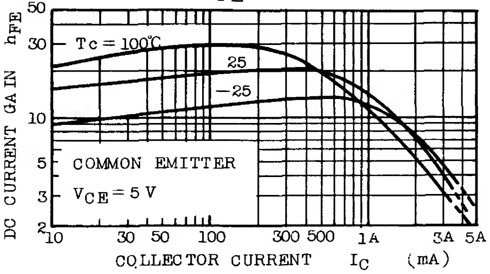
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.8A	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=3A, I_B=0.8A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time	t_f	I_{CP}=3A, $I_{B1(end)}$=0.8A(Fig.)	-	0.5	1.0	μs

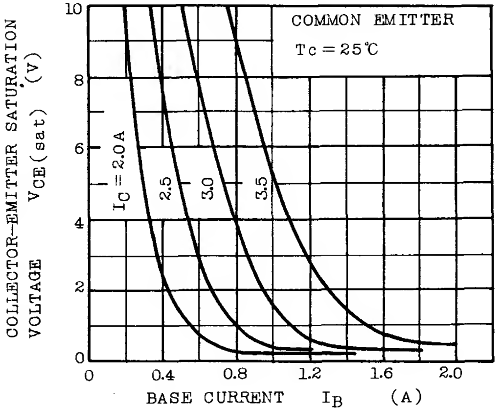
Fig. t_f TEST CIRCUIT



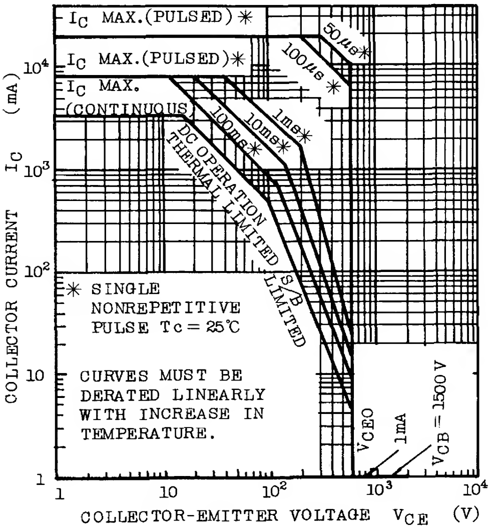
h_{FE} — I_C



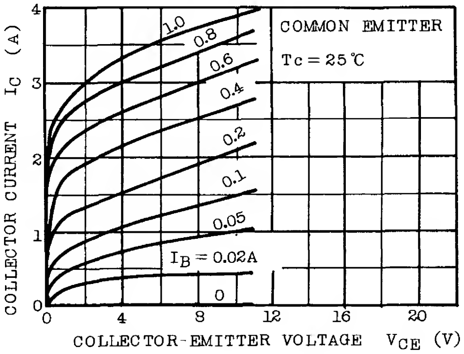
$V_{CE(sat)}$ — I_B



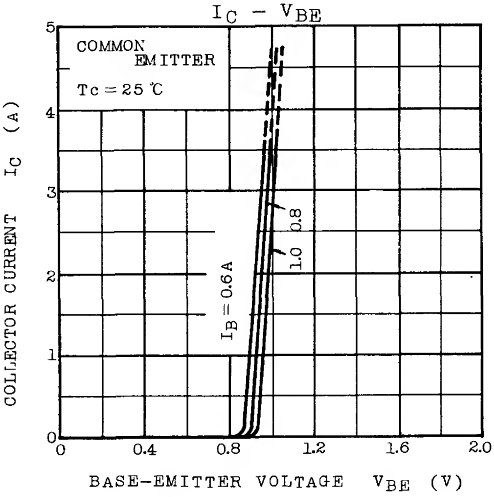
SAFE OPERATING AREA



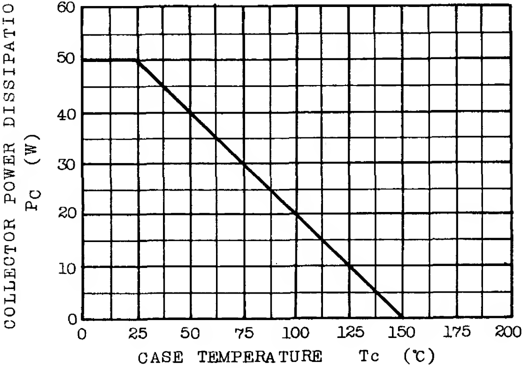
I_C — V_{CE}



I_C — V_{BE}



P_C — Tc



2SD820

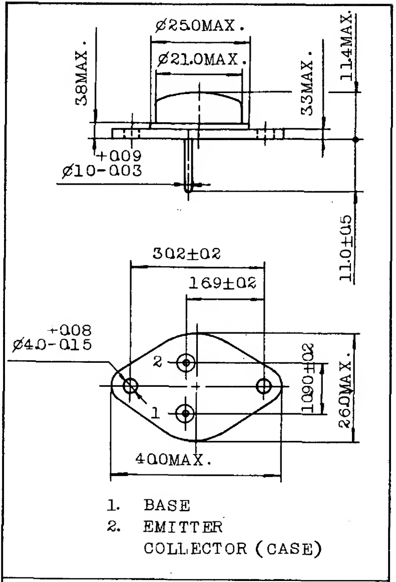
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=4A, I_B=0.8A)
- High Speed : t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

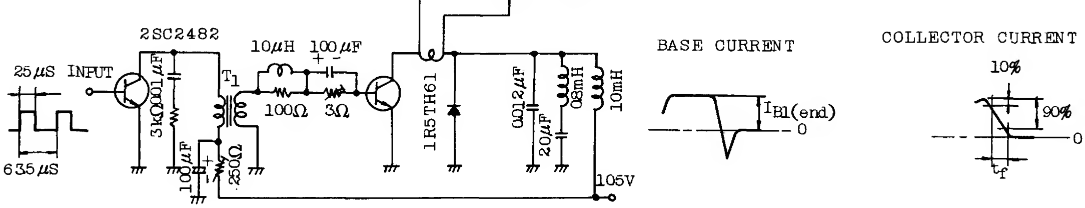
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.8A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=4A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



SILICON NPN TRIPLE DIFFUSED MESA TYPE

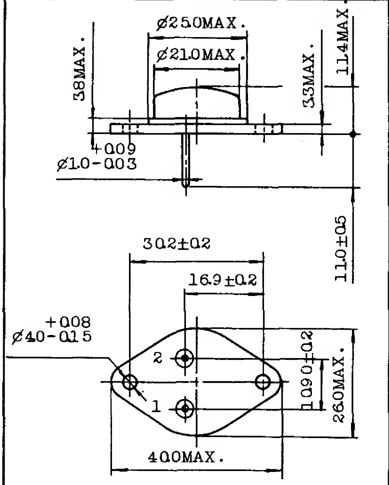
2SD821

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=5A, I_B=1A)
- High Speed : t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

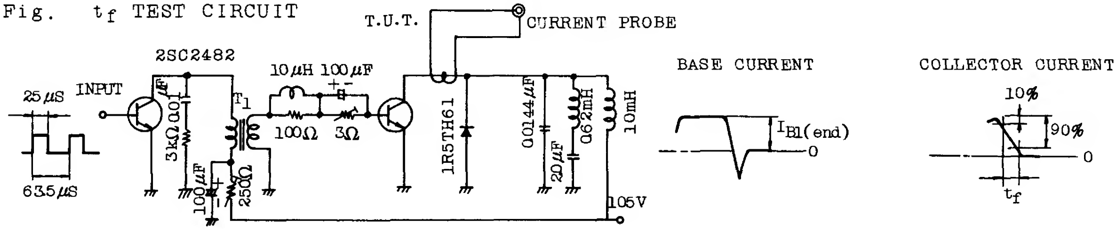
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

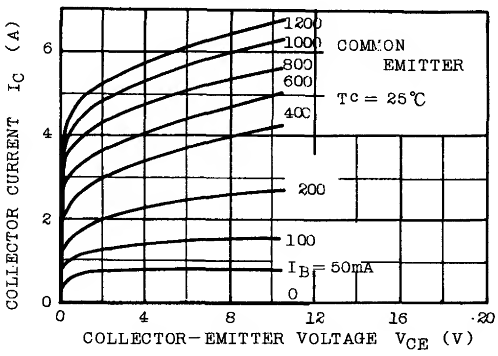
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=1A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=5A, $I_{B1(end)}$=1A	-	0.5	1.0	μs

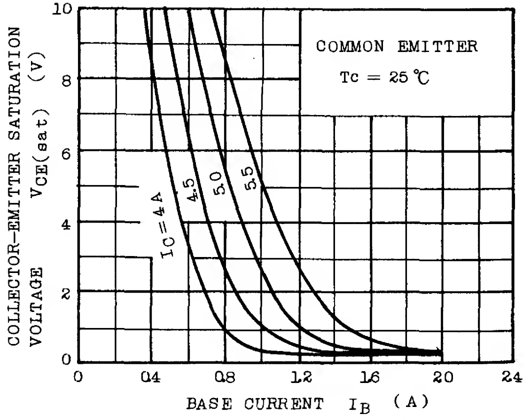
Fig. t_f TEST CIRCUIT



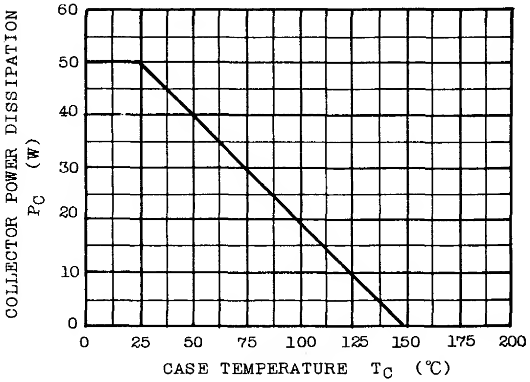
V_{CE} — I_C



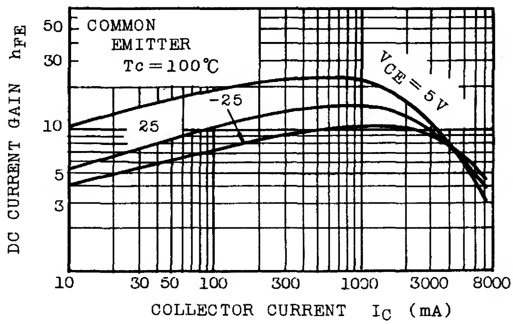
$V_{CE(sat)}$ — I_B



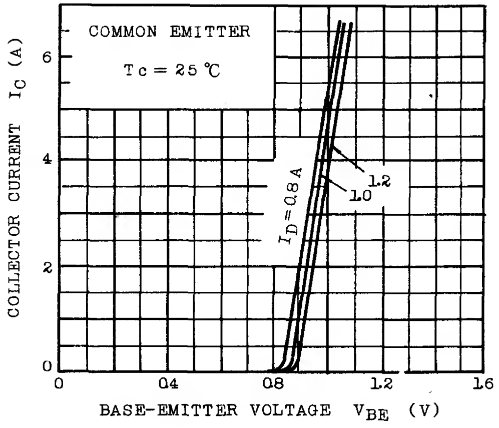
P_C — T_C



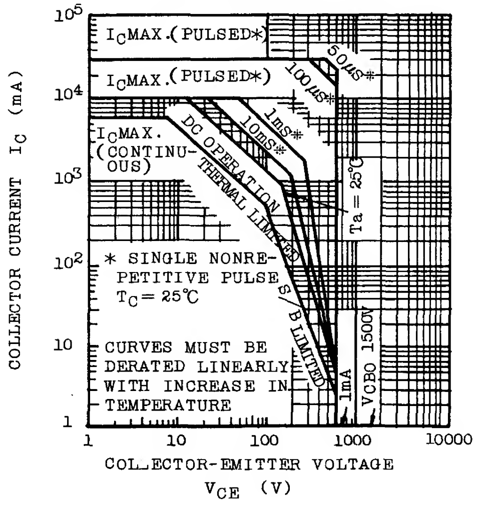
h_{FE} - I_C



I_C — V_{BE}



SAFE OPERAING AREA



SILICON NPN TRIPLE DIFFUSED MESA TYPE

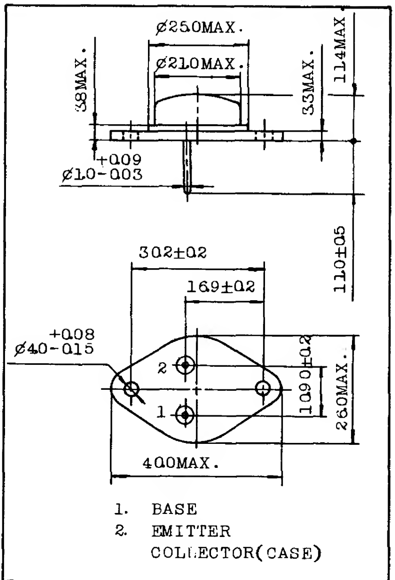
2SD822

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=6A, I_B=1.2A)
- High Speed ; t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



JEDEC	TO-3
EIAJ	TC-3 , TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

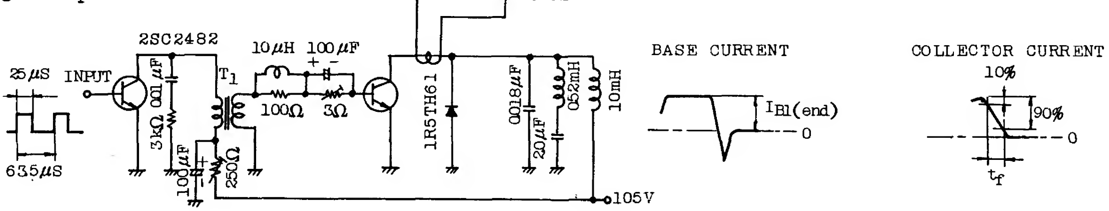
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

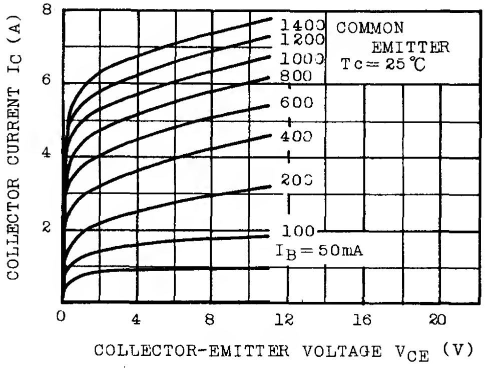
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=6A, I_B=1.2A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=6A, I_B=1.2A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=6A, $I_{B1(end)}$=1.2A	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT

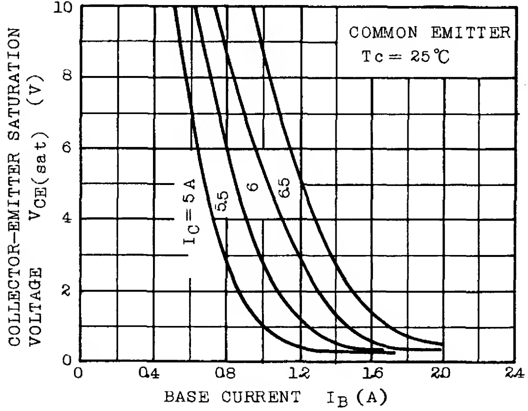


TOSHIBA CORPORATION

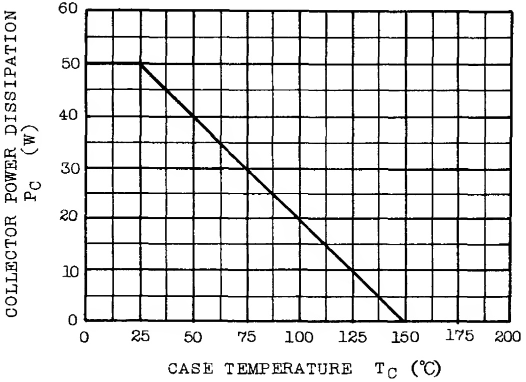
V_{CE} − I_C



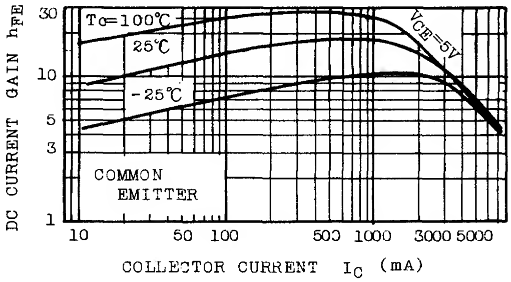
$V_{CE(sat)}$ − I_B



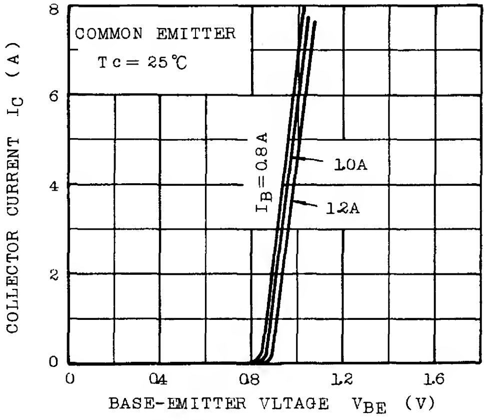
P_C − T_C



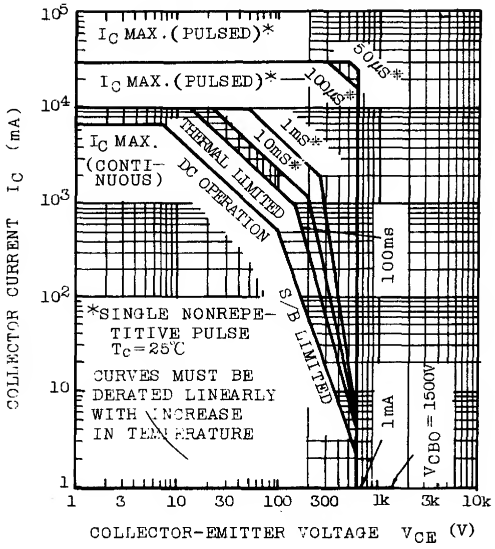
h_{FE} − I_C



I_C − V_{BE}



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED MESA TYPE

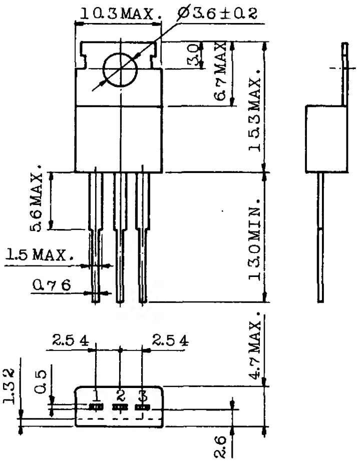
2SD841

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=800V
- Low $V_{CE(sat)}$: $V_{CE(sat)}$=1.0V(Max.)(I_C=0.5A, I_B=0.05A)
- High Speed Switching : t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

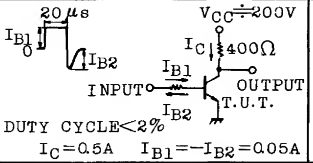
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Weight : 1.9g
Mounting kit No. AC75

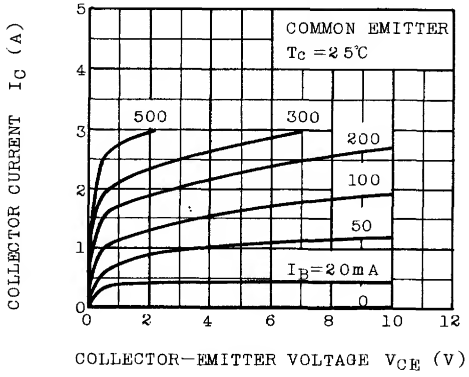
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	800	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	3	A
Base Current		I_B	1.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

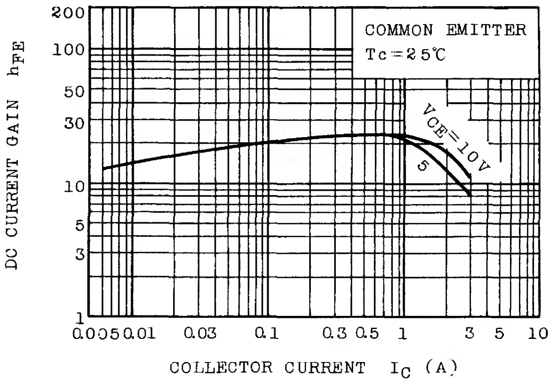
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=800V, I_E=0	-	-	1	mA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain	$h_{FE(1)}$	V_{CE}=5V, I_C=10mA	8	-	-	
	$h_{FE(2)}$	V_{CE}=5V, I_C=0.5A	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=0.5A, I_B=0.05A	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=0.5A, I_B=0.05A	-	-	1.5	V
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	75	-	pF
Transition Frequency	f_T	V_{CE}=10V, I_E=-0.1A	-	4	-	MHz
Fall Time	t_f		-	-	1.0	μs

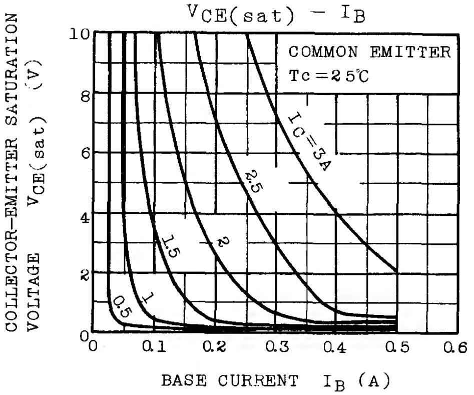
I_C - V_{CE}



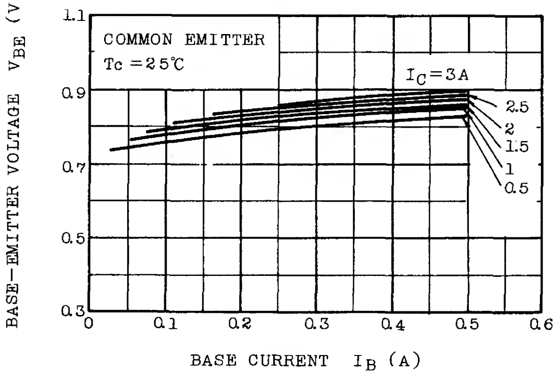
h_{FE} — I_C



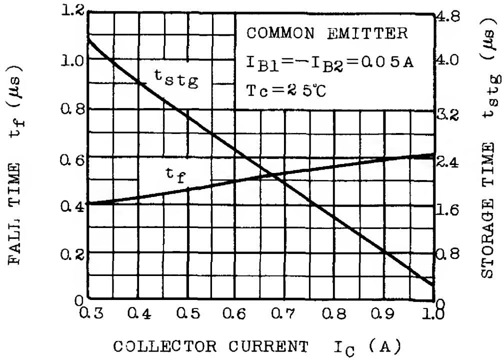
$V_{CE(sat)}$ — I_B



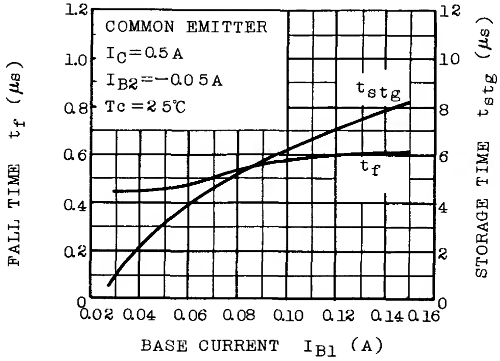
V_{BE} — I_B

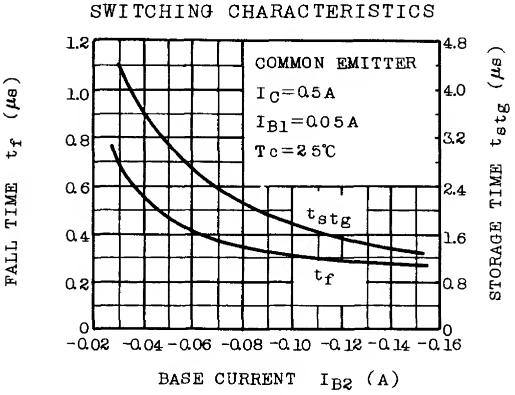


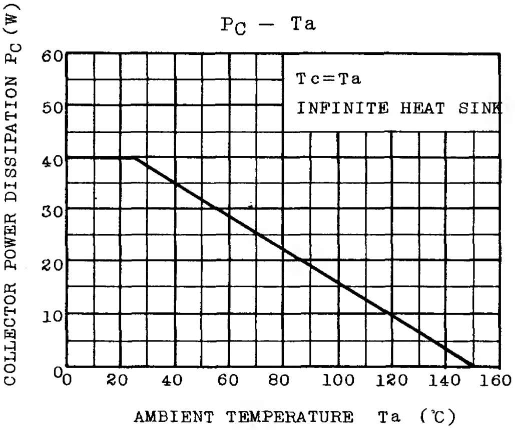
SWITCHING CHARACTERISTICS

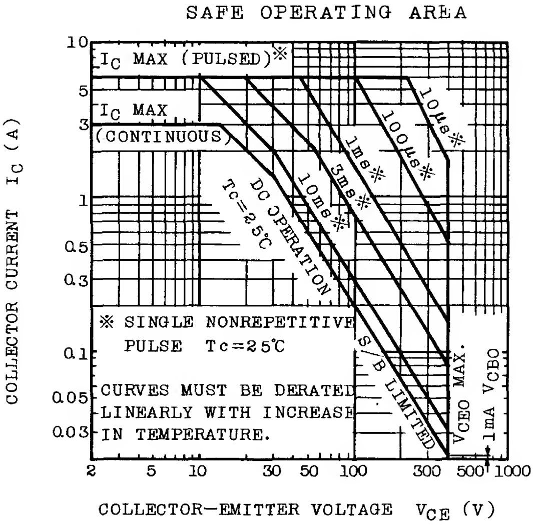


SWITCHING CHARACTERISTICS




SWITCHING CHARACTERISTICS
COMMON EMITTER
I_C=0.5A
I_{B1}=0.05A
Tc=25℃
t_{stg}
t_f
FALL TIME t_f (μs)
STORAGE TIME t_{stg} (μs)
1.2
1.0
0.8
0.6
0.4
0.2
0
4.8
4.0
3.2
2.4
1.6
0.8
0
-0.02 -0.04 -0.06 -0.08 -0.10 -0.12 -0.14 -0.16
BASE CURRENT I_{B2} (A)


P_C — Ta
Tc=Ta
INFINITE HEAT SINK
COLLECTOR POWER DISSIPATION P_C (W)
60
50
40
30
20
10
0
0 20 40 60 80 100 120 140 160
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
I_C MAX (PULSED)※
I_C MAX
(CONTINUOUS)
10μs※
100μs※
1ms※
3ms※
10ms※
DC OPERATION
Tc=25°C
S/B LIMITED
V_{CBO} MAX.
1mA V_{CBO}
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
COLLECTOR CURRENT I_C (A)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
2 5 10 30 50 100 300 500 1000
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

2SD842

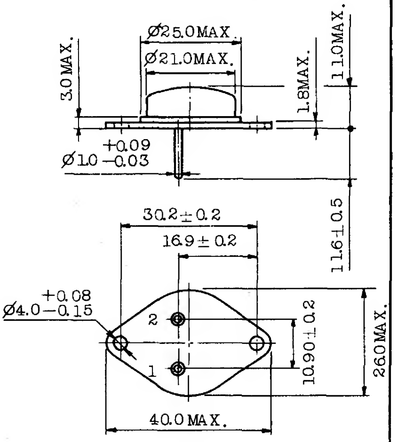
SILICON NPNTRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- High Collector Current : I_C = 30A
- High DC Current Gain
  : h_{FE}=1000(Min.),(V_{CE}=5V, I_C=20A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

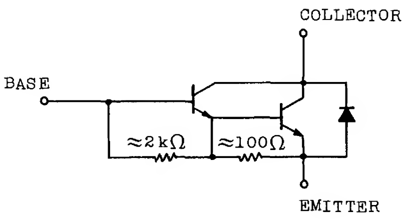
JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21A1A

Mounting kit No. AC73
Weight : 12.9g

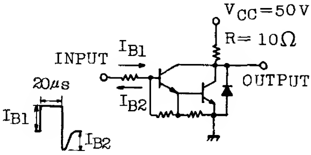
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	30	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

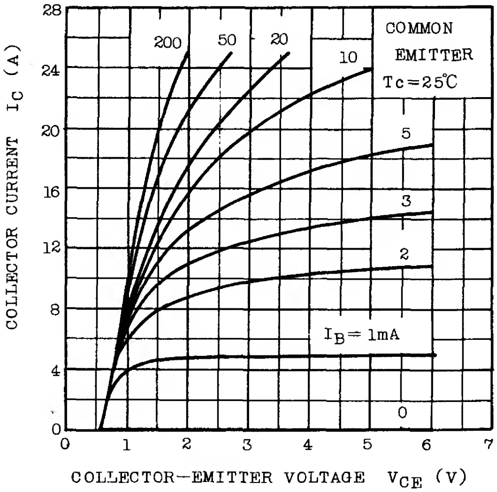
EQUIVALENT CIRCUIT



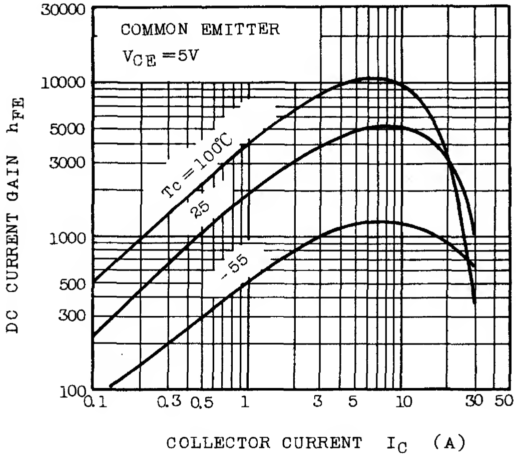
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE}(1)$	V_{CE}=5V, I_C=20A	1000	-	-	
		$h_{FE}(2)$	V_{CE}=5V, I_C=30A	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=20A, I_B=0.2A	-	-	3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	3.5	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=10A, I_B=0	-	-	3	V
Transition Frequency		f_T	V_{CE}=5V, I_C=1A	-	14	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	280	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.7	-	μs
	Storage Time	t_{stg}	I_{B1}= $-I_{B2}$=0.01A DUTY CYCLE≦1%	-	8	-	
	Fall Time	t_f		-	2.5	-	

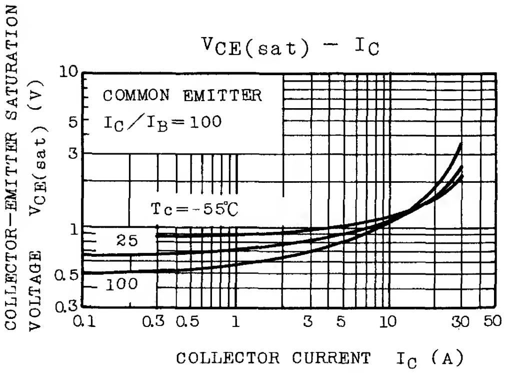
I_C – V_{CE}



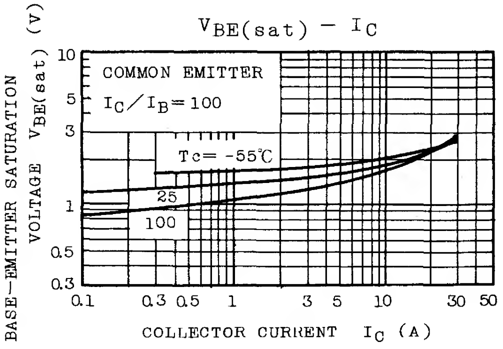
h_{FE} – I_C



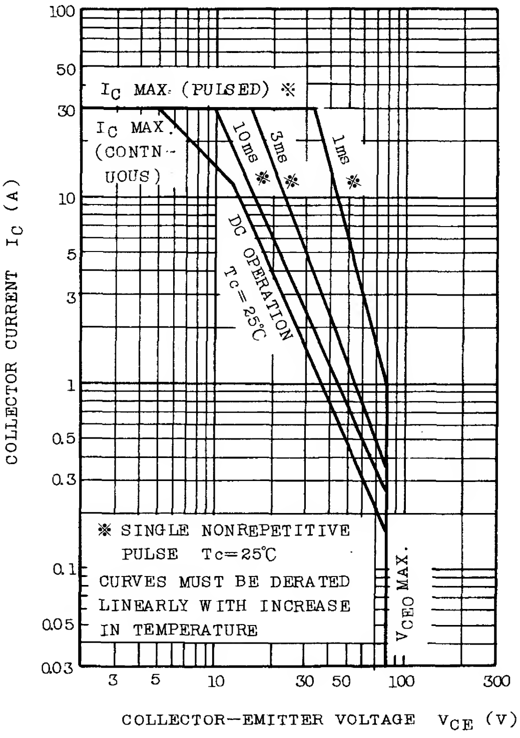
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

SILICON NPN TRIPLE DIFFUSED TYPE

2SD843

INDUSTRIAL APPLICATIONS

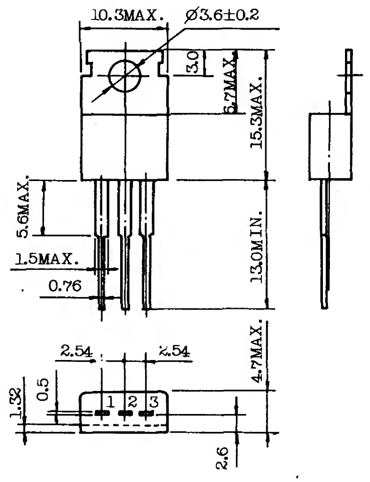
HIGH CURRENT SWITCHING APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
  : $V_{CE(sat)}$=0.5V (Max.) (at I_C=4A)
- Complementary to 2SB753.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO — 220AB
EIAJ	SC — 46
TOSHIBA	2 —10A1A

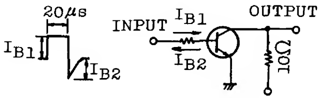
Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

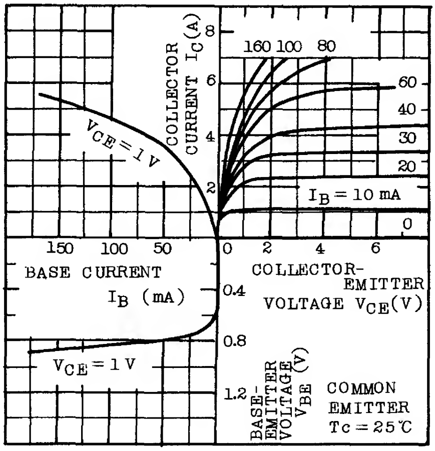
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

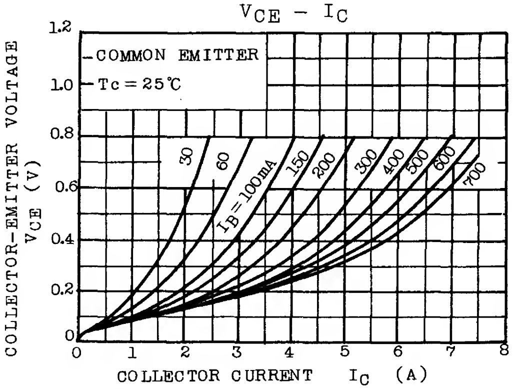
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.4A	-	0.9	1.4	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω	-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f	I_{B1}=$-I_{B2}$=0.3A V_{CC}=30V DUTY CYCLE≦1%	-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70∿140, Y : 120∿240

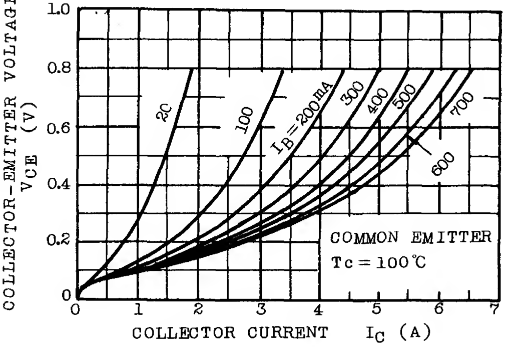
STATIC CHARACTERISTICS



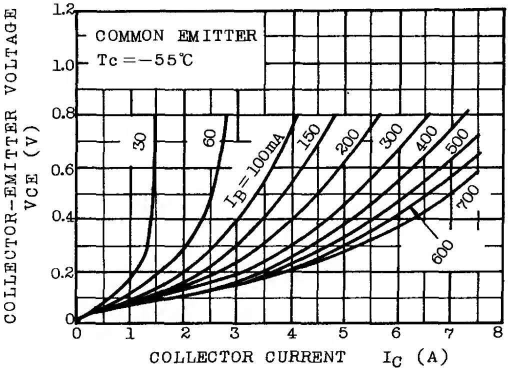
V_{CE} – I_C



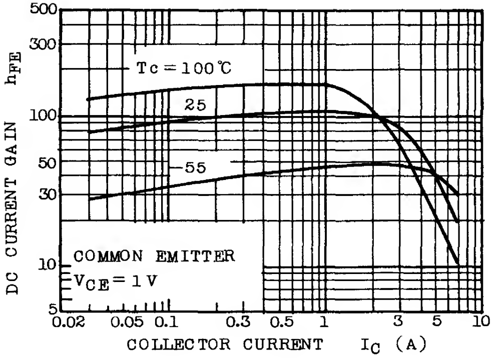
V_{CE} – I_C



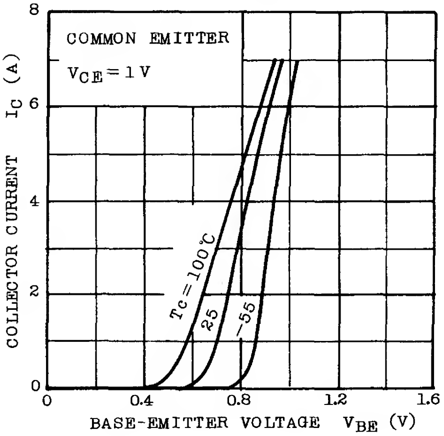
V_{CE} – I_C



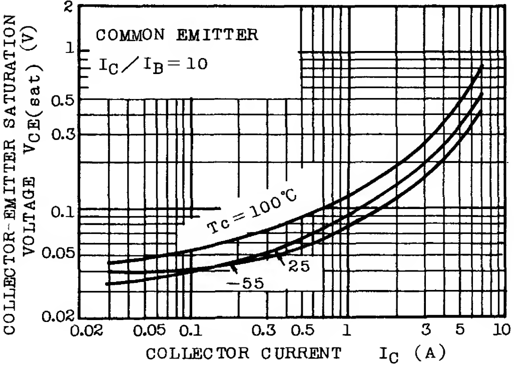
h_{FE} – I_C



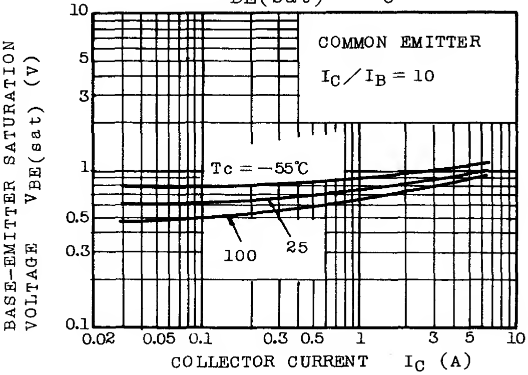
I_C – V_{BE}



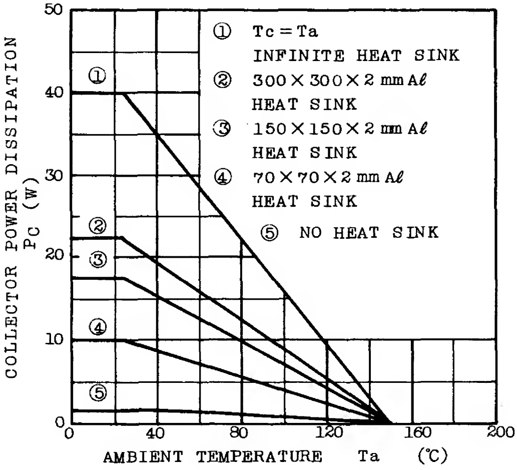
$V_{CE(sat)} - I_C$



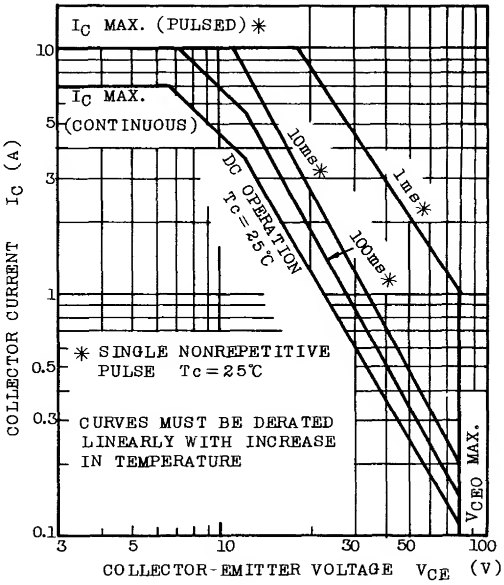
$V_{BE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



2SD844

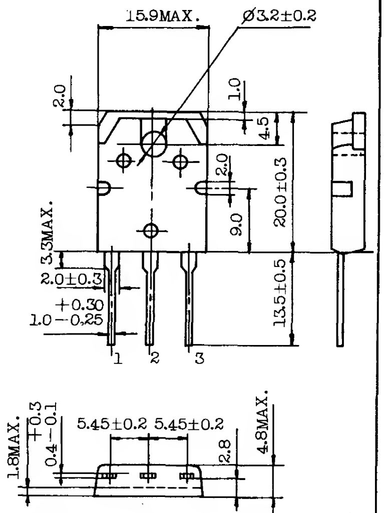
SILICON NPN TRIPLE DIFFUSED TYPE

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATION.

FEATURES:

- High Collector Current : I_C=7A
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) (at I_C=4A)
- High Power dissipation : P_C=60W (at Tc=25°C)
- Complementary to 2SB754.

Unit in mm



1. BASE 2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 16B1A

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

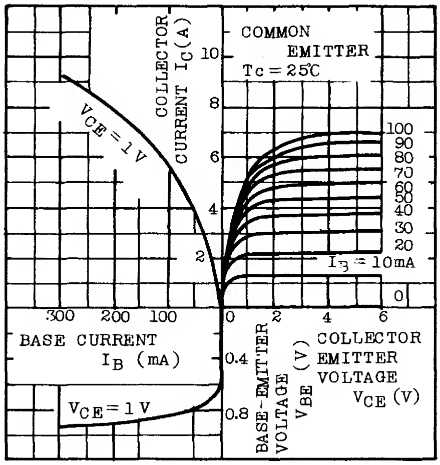
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Emitter Current		I_E	-7	A
Collector Power Dissipation	Ta=25°C	P_C	2.5	W
	Tc=25°C		60	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

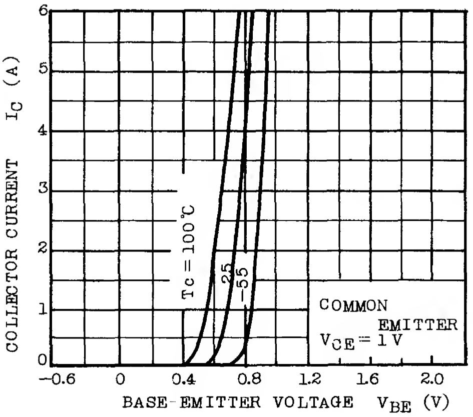
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=50V, I_E=0	–	–	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	–	–	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	–	–	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	–	–	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	–	240	
	$h_{FE(2)}$	V_{CE}=1V, I_C=4A	30	–	–	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	–	0.2	0.4	V
Base-Emitter Voltage	V_{BE}	V_{CE}=1V, I_C=4A	–	0.9	1.2	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	–	15	–	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	–	250	–	pF

Note : $h_{FE(1)}$ Classification O : 70 ∿140, Y : 120 ∿ 240

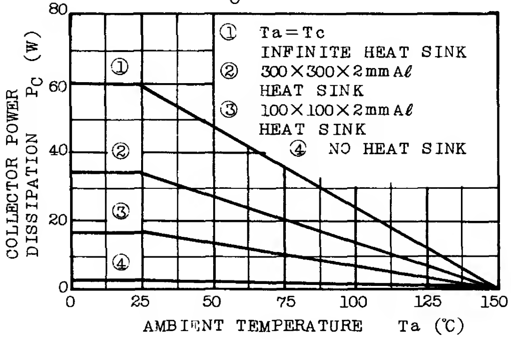
STATIC CHARACTERISTICS



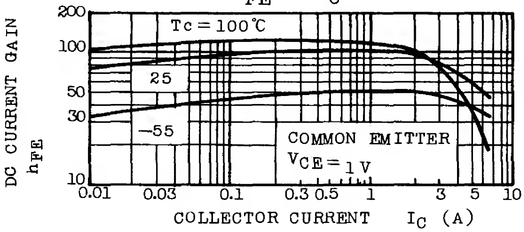
I_C – V_{BE}



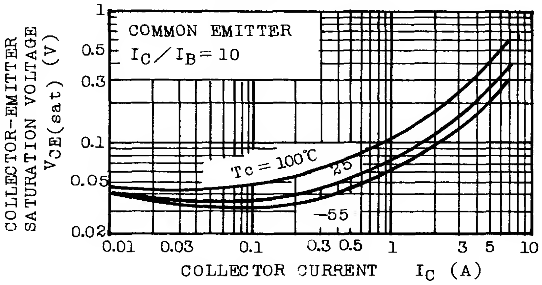
P_C – Ta



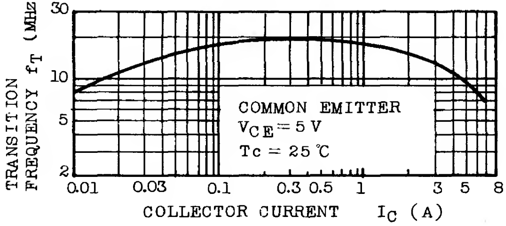
h_{FE} – I_C



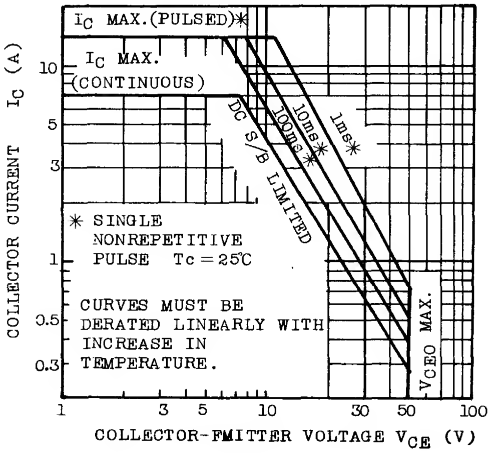
$V_{CE(sat)}$ – I_C



f_T – I_C



SAFE OPERATING AREA



2SD845

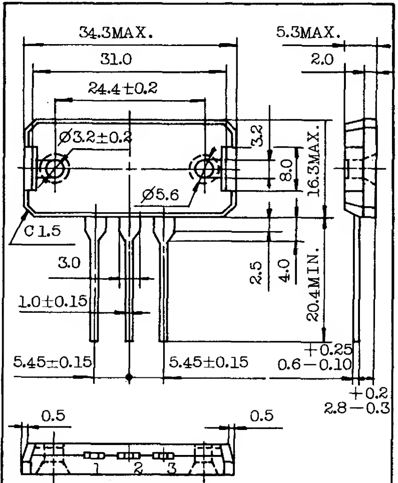
SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATION.

FEATURES:

- High Breakdoun Voltage : V_{CEO}=150V (Min.)
- High Transition Frequency : f_T=20MHz (Typ.)
- Complementary to 2SB755.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2 — 34 A 1 A

Weight : 10.8g

MAXIMUM RATINGS (Ta=25°C)

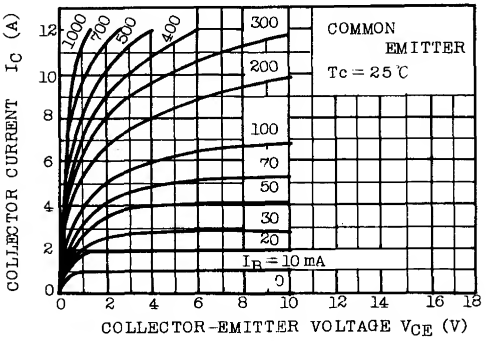
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	150	V
Collector-Emitter Voltage	V_{CEO}	150	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	12	A
Emitter Current	I_E	-12	A
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

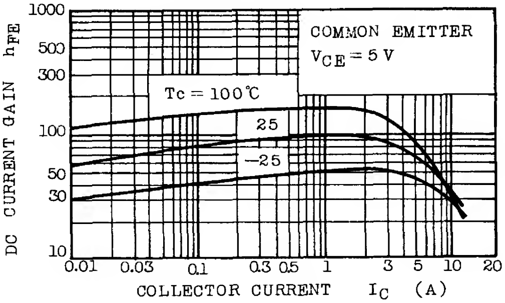
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=150V, I_E=0	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=0.1A, I_B=0	150	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_E=0	5	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=1A	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	20	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	200	-	pF

Note : h_{FE} Classification R : 55∿110, O : 80∿160

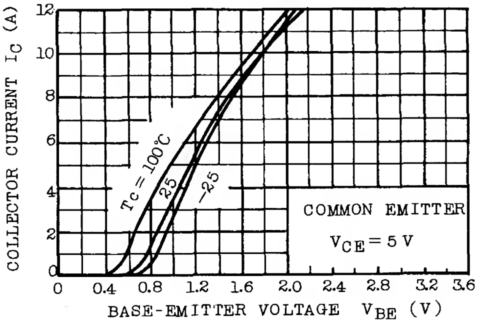
I_C – V_{CE}



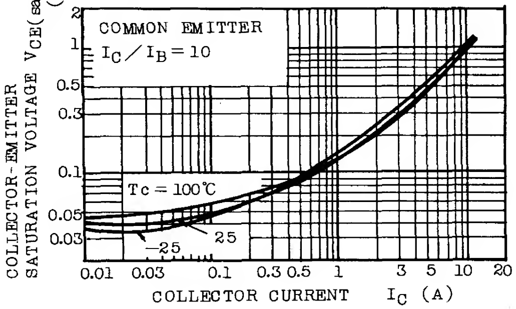
h_{FE} – I_C



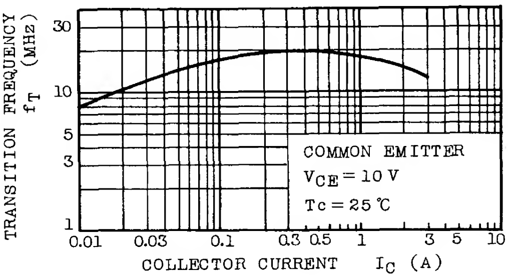
I_C – V_{BE}



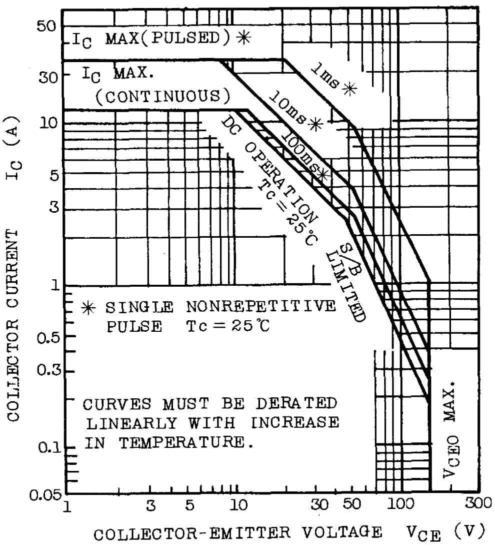
$V_{CE(sat)}$ – I_C



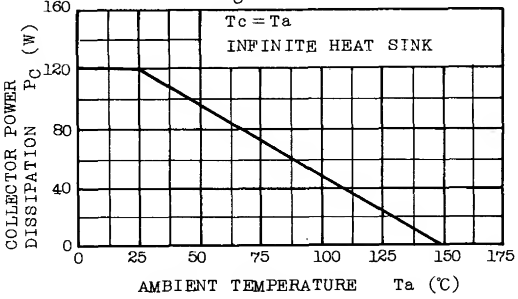
f_T – I_C



SAFE OPERATING AREA



P_C – Ta



2SD867

SILICON NPN TRIPLE DIFFUSED TYPE

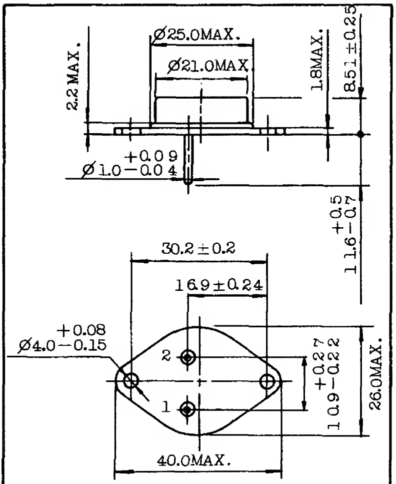
INDUSTRIAL APPLICATIONS

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATONS.

FEATURES:

- High Power Dissipation : P_C=100W(Tc=25°C)
- High Collector Current : I_C=10A
- Low Saturaton Voltage : $V_{CE(sat)}$=0.5V (Typ.)(I_C=5A)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

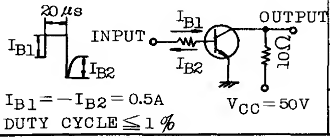
JEDEC	TO−204MA/TO−3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21D1A

Mounting Kit No. AC73
Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

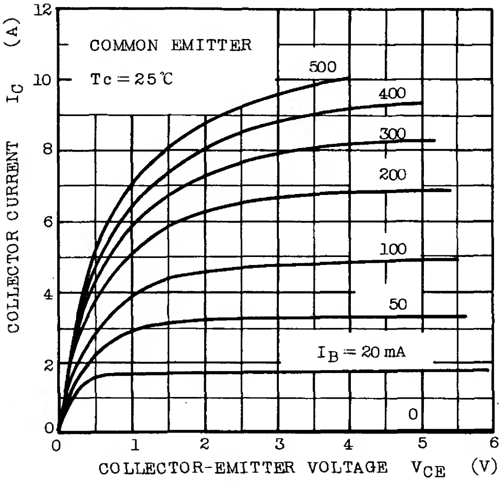
CHARACTERISTICS	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	130	V
Collector-Emitter Voltage	V_{CEO}	110	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

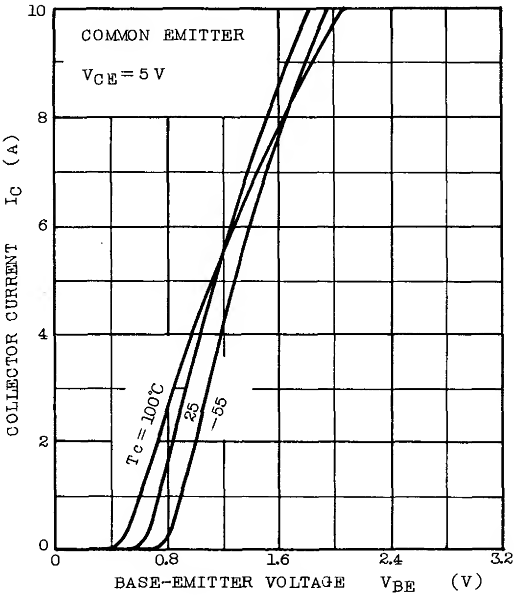
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=130V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	110	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	50	-	200	
		$h_{FE(2)}$	V_{CE}=5V, I_C=5A	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=5A, I_B=1A	-	0.5	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	1.2	2.5	V
Transition Frequency		f_T	V_{CE}=5V, I_C=1A	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	200	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω $I_{B1}=-I_{B2}=0.5A$ DUTY CYCLE≦1% $V_{CC}=50V$	-	2.5	-	μs
	Storage Time	t_{stg}		-	4.0	-	
	Fall Time	t_f		-	1.2	-	

Note : $h_{FE(1)}$ Classification O : 50∿120, Y : 100∿200

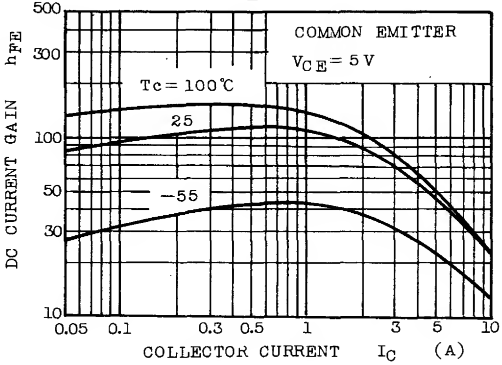
$I_C - V_{CE}$



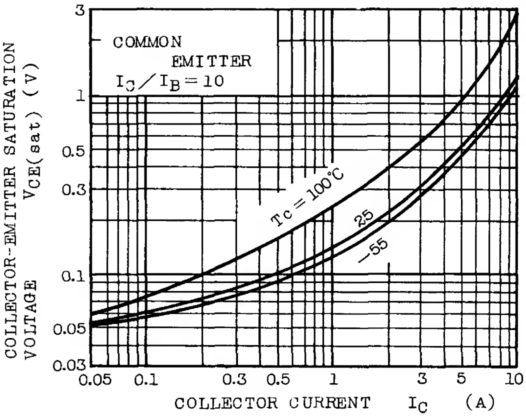
$I_C - V_{BE}$



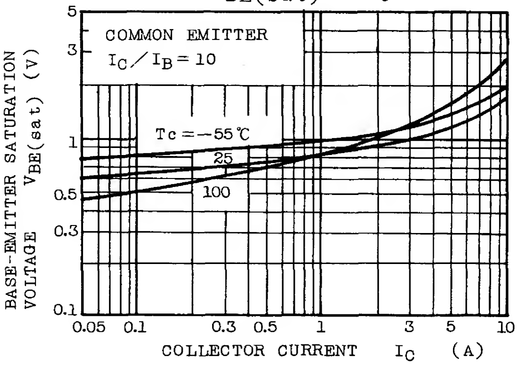
$h_{FE} - I_C$

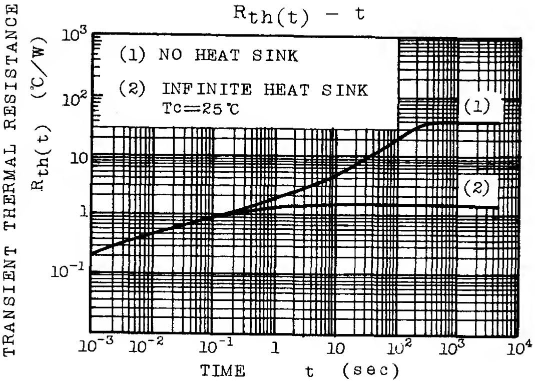


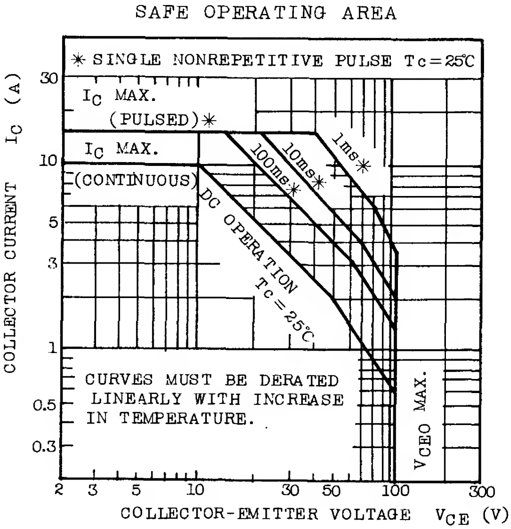
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$




Rth(t) − t
(1) NO HEAT SINK
(2) INFINITE HEAT SINK
Tc=25°C
(1)
(2)
TRANSIENT THERMAL RESISTANCE
Rth(t) (°C/W)
10^3
10^2
10
1
10^-1
10^-3
10^-2
10^-1
1
10
10^2
10^3
10^4
TIME t (sec)


SAFE OPERATING AREA
✻ SINGLE NONREPETITIVE PULSE Tc=25°C
IC MAX.
(PULSED)✻
IC MAX.
(CONTINUOUS)
1ms✻
10ms✻
100ms✻
DC OPERATION
Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.
COLLECTOR CURRENT IC (A)
30
10
5
3
1
0.5
0.3
2
3
5
10
30
50
100
300
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

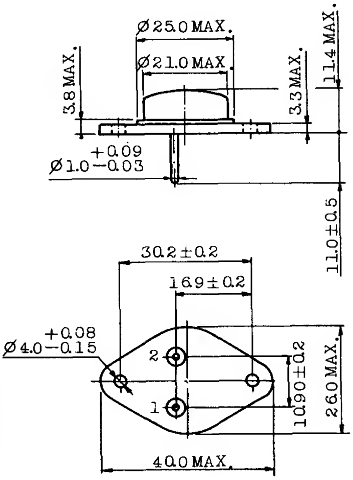
2SD868

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V(Typ.) (I_C=2A, I_B=0.6A)
- High Speed : t_f=1.0μs(Max.) (I_{CP}=2A, $I_{B1(end)}$=0.6A)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR(CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

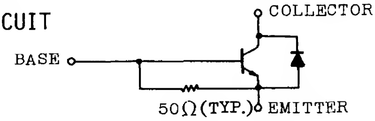
Mounting Kit No. AC42C

Weight : 17g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	-65~150	°C

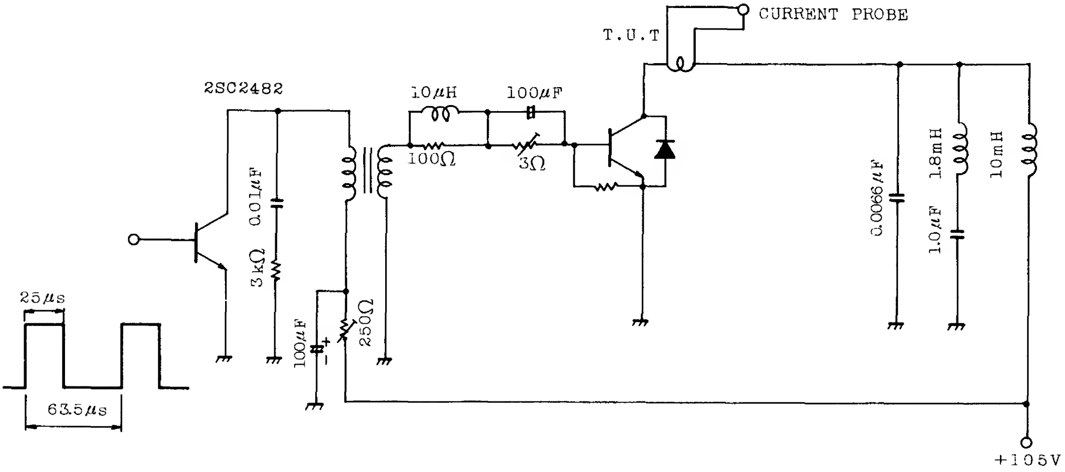
EQUIVALENT CIRCUIT

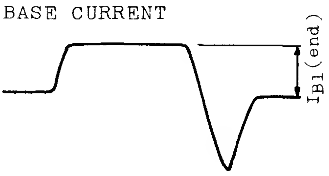


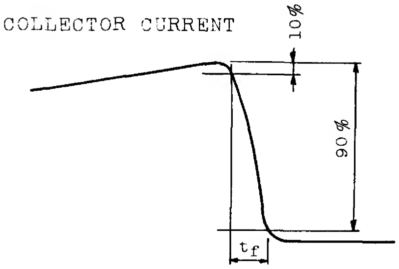
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.6A	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2A, I_B=0.6A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=2.5A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time	t_f	I_{CP}=2A, $I_{B1(end)}$=0.6A	-	0.5	1.0	μs

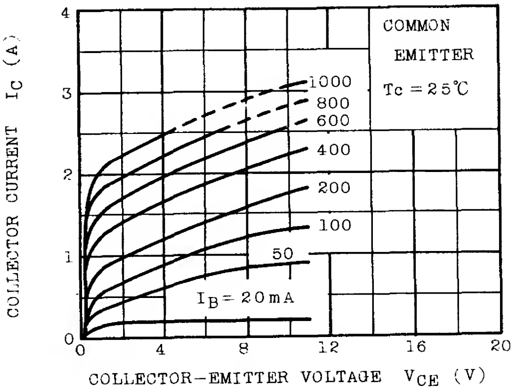
t_f TEST CIRCUIT



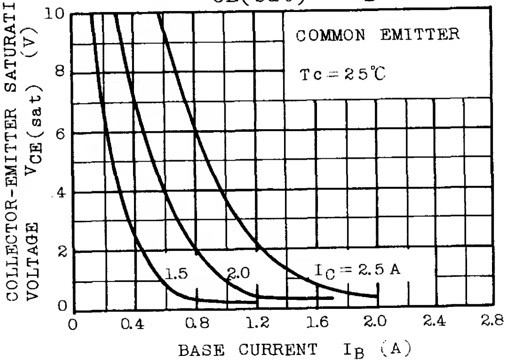




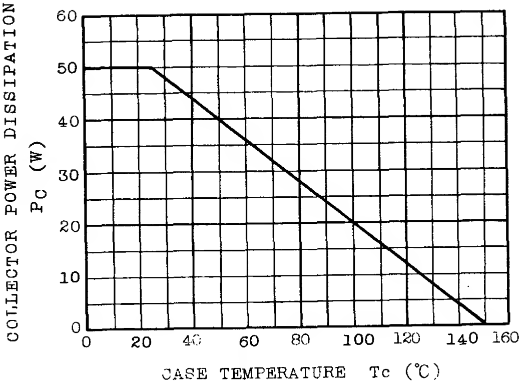
$V_{CE} - I_C$



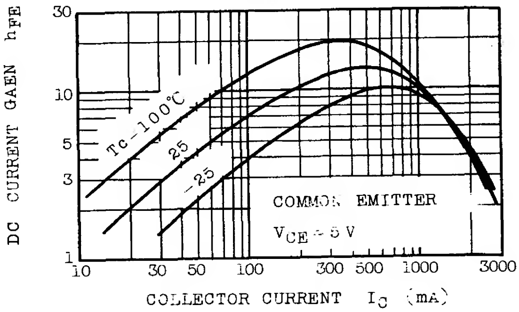
$V_{CE(sat)} - I_B$



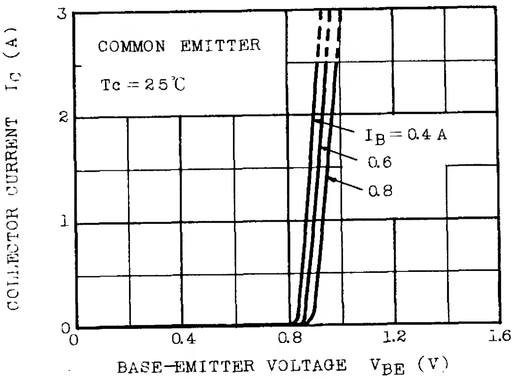
$P_C - T_C$



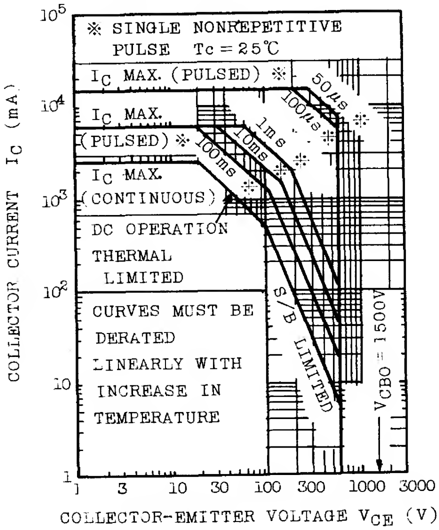
$h_{FE} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA



2SD869

SILICON NPN TRIPLE DIFFUSED MESA TYPE

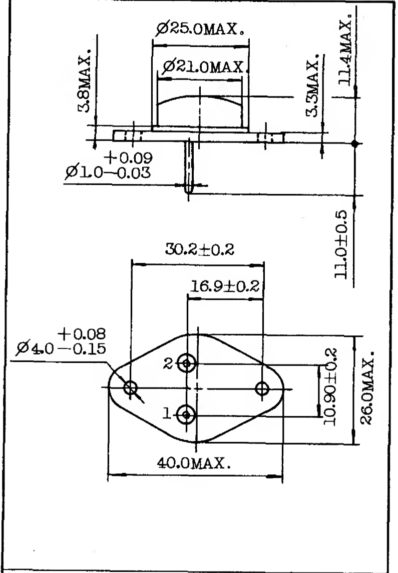
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Typ.) (I_C=3A, I_B=0.8A)
- High Speed : t_f=1.0μs (Max.)
  (I_{CP}=3A, $I_{B1(end)}$=0.8A)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

INDUSTRIAL APPLICATIONS

Unit in mm



JEDEC	TO − 3
EIAJ	TC − 3, TB − 3
TOSHIBA	2−21B1A

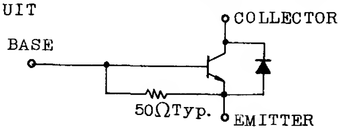
Mounting Kit No. AC42C

Weight : 17g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65∿150	°C

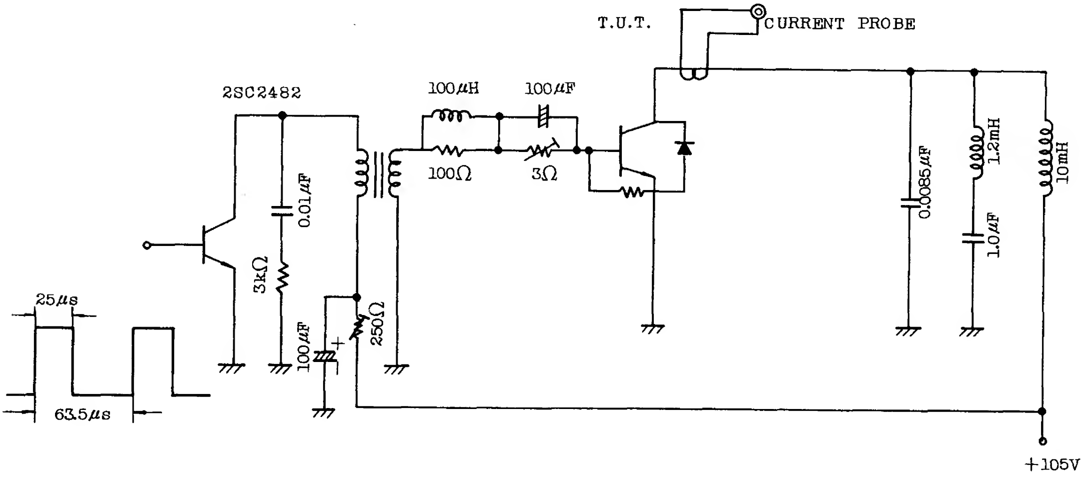
EQUIVALENT CIRCUIT

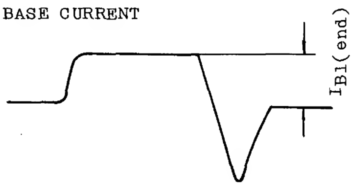


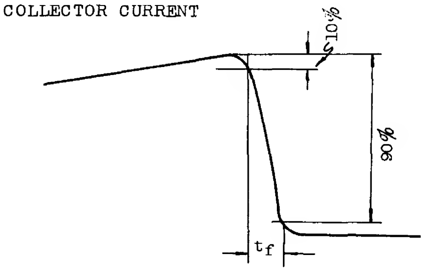
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	−	−	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	−	−	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	12	−	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.8A	−	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=3A, I_B=0.8A	−	−	1.5	V
Forward Voltage(Damper Diode)	$-V_F$	I_F=3.5A	−	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	−	3	−	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	95	−	pF
Fall Time (Fig.)	t_f	I_{CP}=3A, $I_{B1(end)}$=0.8A	−	0.5	1.0	μs

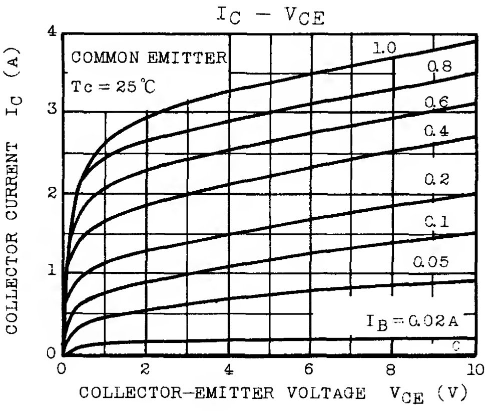
Fig. t_f TEST CIRCUIT



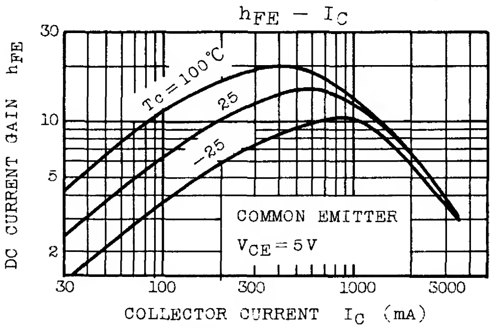




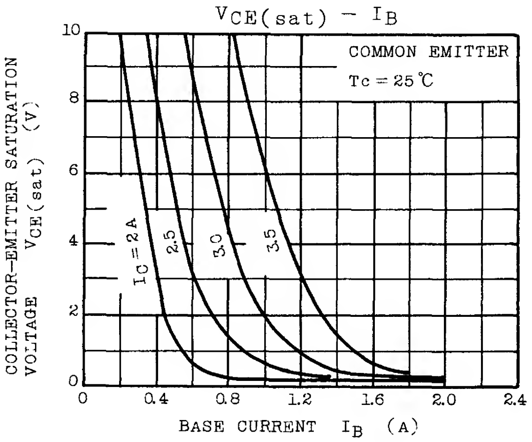
2SD869



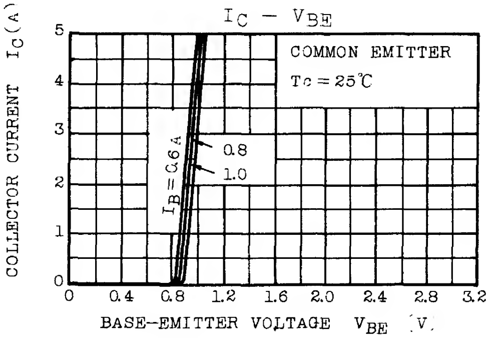
$I_C - V_{CE}$
COMMON EMITTER
Tc = 25℃
1.0
0.8
0.6
0.4
0.2
0.1
0.05
I_B = 0.02A
0
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
2
4
6
8
10
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)



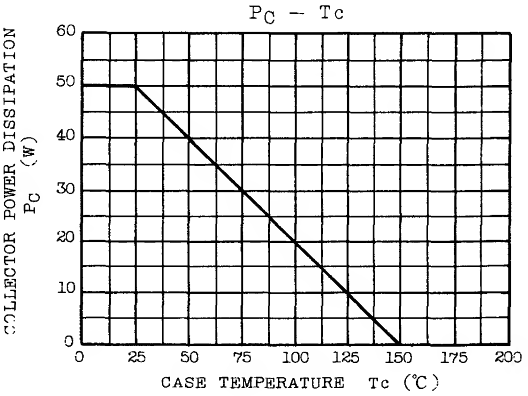
$h_{FE} - I_C$
Tc = 100℃
25
−25
COMMON EMITTER
V_{CE} = 5V
DC CURRENT GAIN h_{FE}
30
10
5
2
30
100
300
1000
3000
COLLECTOR CURRENT I_C (mA)



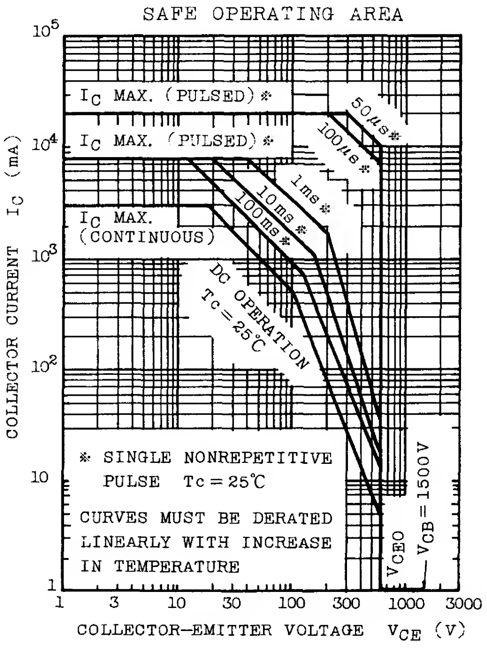
$V_{CE(sat)} - I_B$
COMMON EMITTER
Tc = 25℃
I_C = 2A
2.5
3.0
3.5
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0
2
4
6
8
10
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT I_B (A)



$I_C - V_{BE}$
COMMON EMITTER
Tc = 25℃
I_B = 0.6A
0.8
1.0
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
5
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
BASE-EMITTER VOLTAGE V_{BE} (V)



$P_C - Tc$
COLLECTOR POWER DISSIPATION P_C (W)
0
10
20
30
40
50
60
0
25
50
75
100
125
150
175
200
CASE TEMPERATURE Tc (℃)



SAFE OPERATING AREA
I_C MAX. (PULSED)*
I_C MAX. (PULSED)*
I_C MAX. (CONTINUOUS)
50μs*
100μs*
1ms*
10ms*
100ms*
DC OPERATION
Tc = 25℃
* SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO}
V_{CB} = 1500V
COLLECTOR CURRENT I_C (mA)
10^5
10^4
10^3
10^2
10
1
1
3
10
30
100
300
1000
3000
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

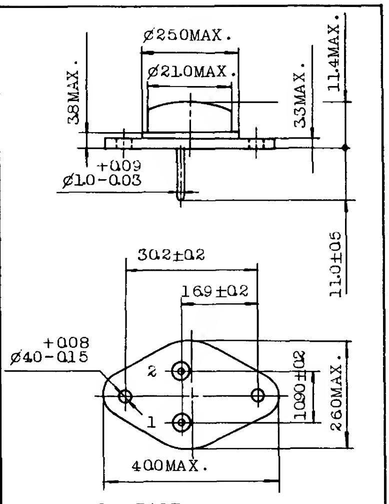
2SD870

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=4A, I_B=0.8A)
- High Speed ; t_f=1.0μs (Max.) (I_{CP}=4A, $I_{B1(end)}$=0.8A)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

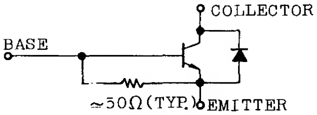
JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

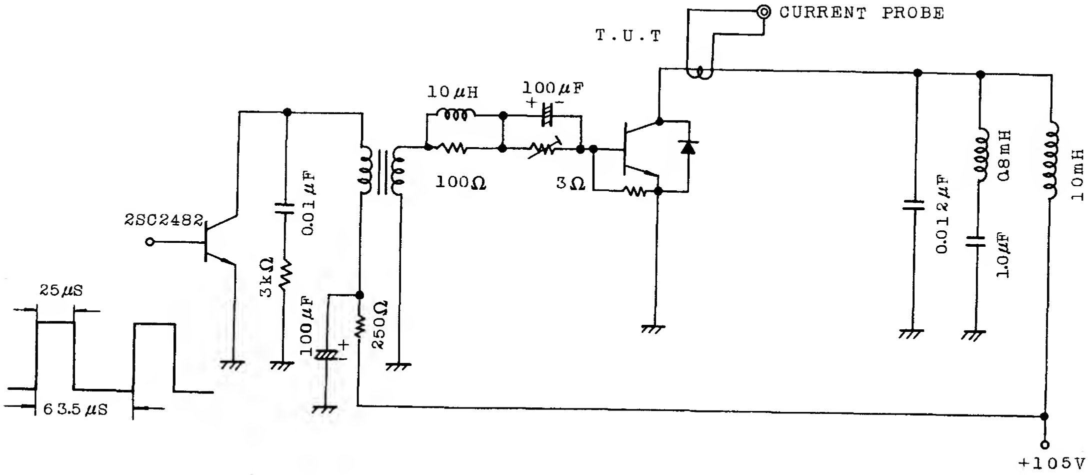
EQUIVALENT CIRCUIT



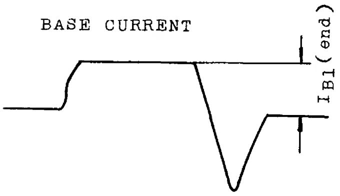
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1.0A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.8A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=5A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=4A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

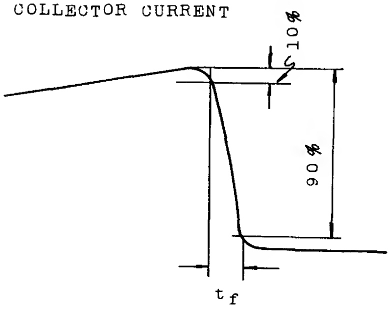
Fig. t_f TEST CIRCUIT

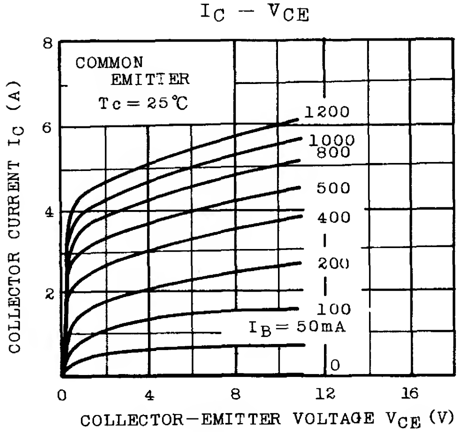


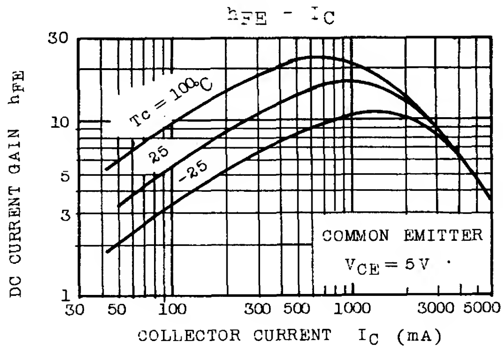
BASE CURRENT

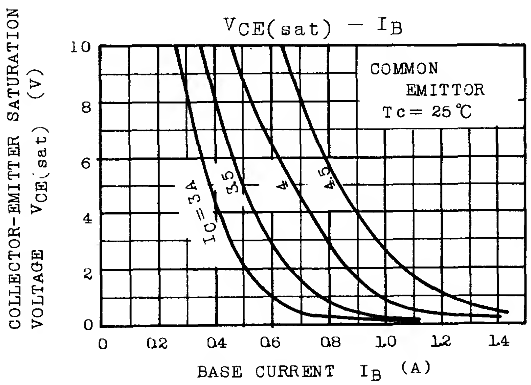


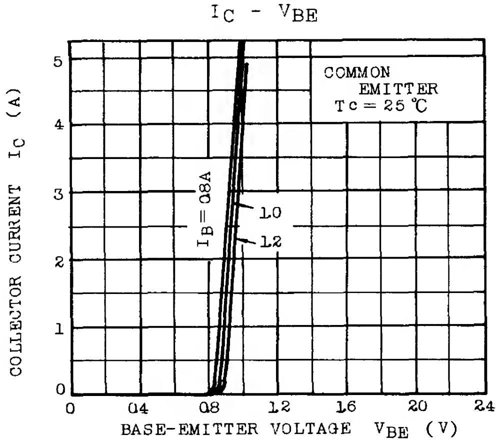
COLLECTOR CURRENT

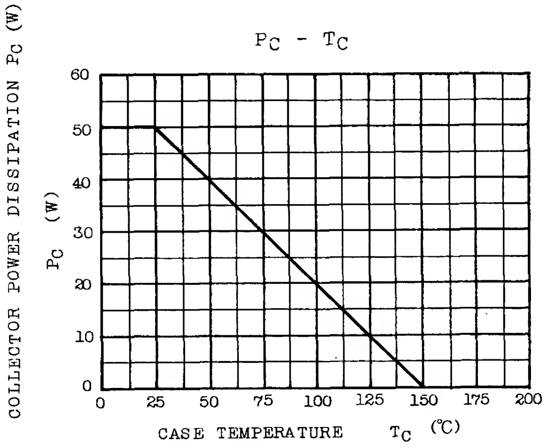


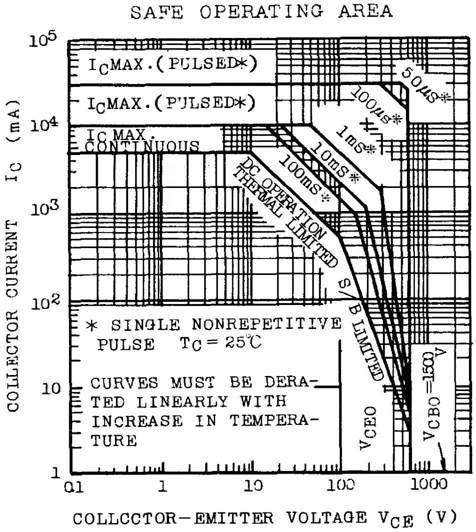

I_C – V_{CE}


h_{FE} – I_C


$V_{CE(sat)}$ – I_B


I_C – V_{BE}


P_C – T_C


SAFE OPERATING AREA

2SD871

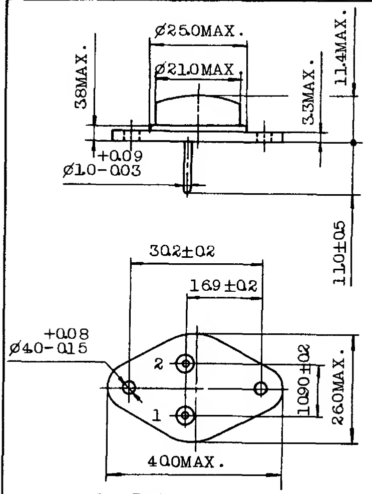
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=5A, I_B=1A)
- High Speed ; t_f=1.0μs (Max.) (I_{CP}=5A, $I_{B1(end)}$=1A)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

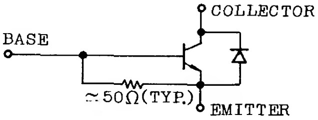
JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting kit No. AC42C
Weight : 17g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

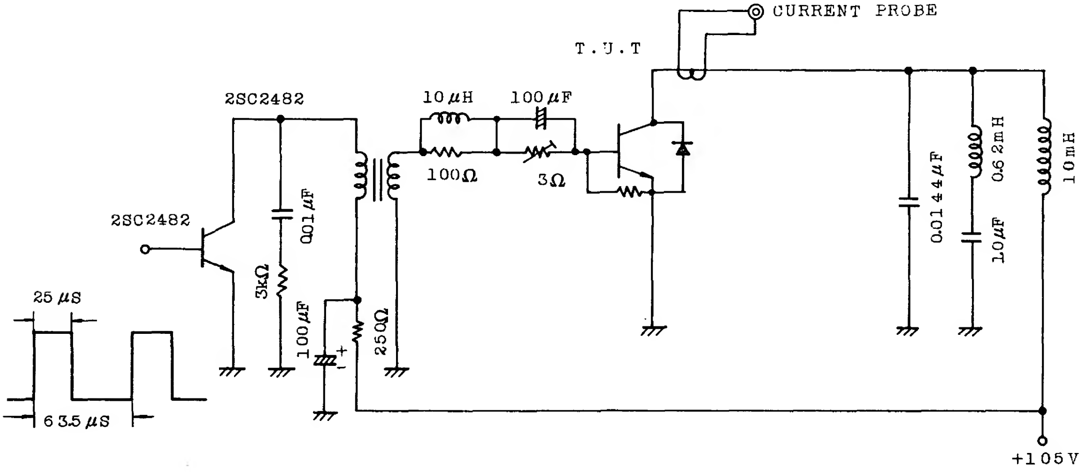
EQUIVALENT CIRCUIT

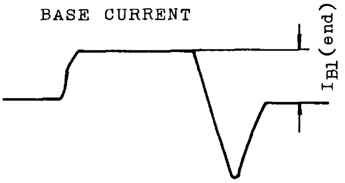


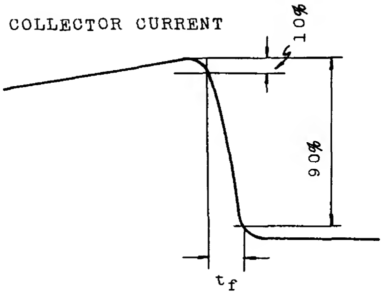
ELECTRICAL CHARACTERISTICS (Ta=25°C)

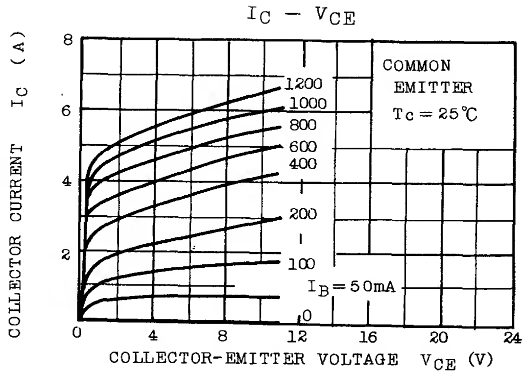
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=1A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=6A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=5A, $I_{B1(end)}$=1A	-	0.5	1.0	μs

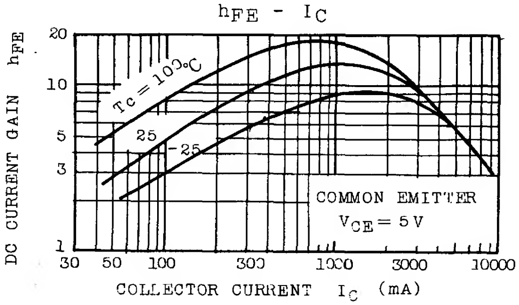
Fig. t_f TEST CIRCUIT

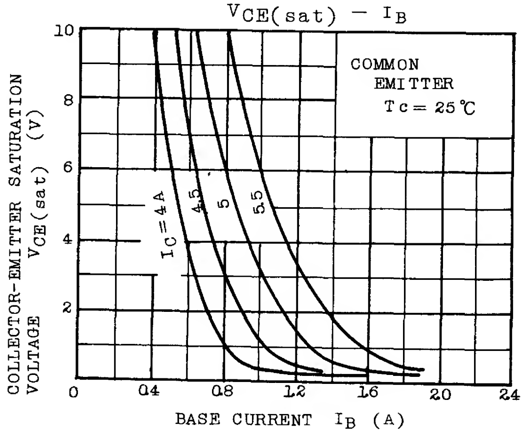


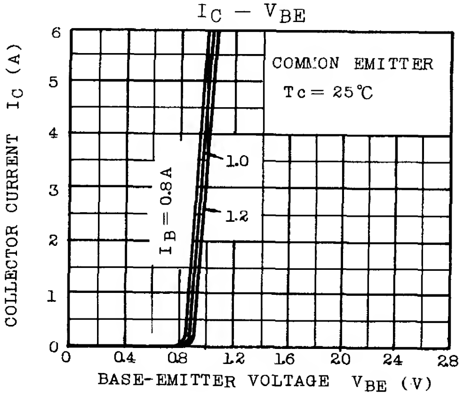


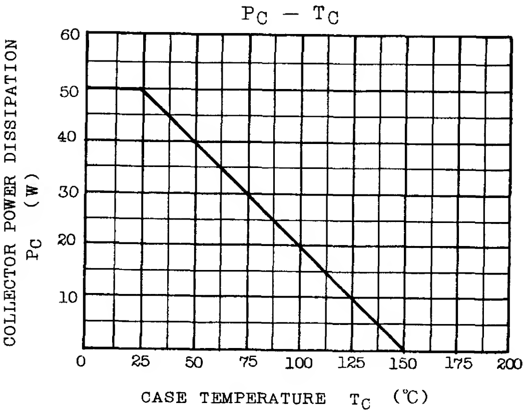


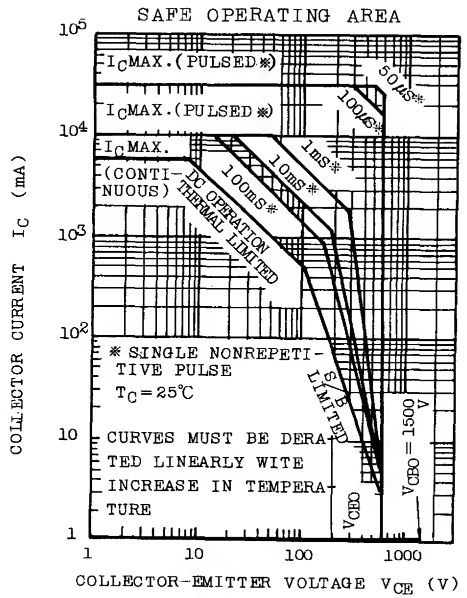

IC — VCE
COMMON EMITTER
Tc = 25℃
1200
1000
800
600
400
200
100
IB = 50mA
0
COLLECTOR CURRENT IC (A)
0
2
4
6
8
4
8
12
16
20
24
COLLECTOR-EMITTER VOLTAGE VCE (V)


hFE - IC
Tc = 100℃
25
-25
COMMON EMITTER
VCE = 5V
DC CURRENT GAIN hFE
1
3
5
10
20
30
50
100
300
1000
3000
10000
COLLECTOR CURRENT IC (mA)


VCE(sat) — IB
COMMON EMITTER
Tc = 25℃
IC = 4A
4.5
5
5.5
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
0
2
4
6
8
10
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT IB (A)


IC — VBE
COMMON EMITTER
Tc = 25℃
IB = 0.8A
1.0
1.2
COLLECTOR CURRENT IC (A)
0
1
2
3
4
5
6
0.4
0.8
1.2
1.6
2.0
2.4
2.8
BASE-EMITTER VOLTAGE VBE (V)


PC — TC
COLLECTOR POWER DISSIPATION PC (W)
10
20
30
40
50
60
0
25
50
75
100
125
150
175
200
CASE TEMPERATURE TC (℃)


SAFE OPERATING AREA
IC MAX. (PULSED ※)
IC MAX. (PULSED ※)
IC MAX. (CONTINUOUS)
50μs※
100μs※
1ms※
10ms※
100ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
※ SINGLE NONREPETITIVE PULSE
TC = 25℃
CURVES MUST BE DERATED LINEARLY WITE INCREASE IN TEMPERATURE
VCEO
VCBO = 1500 V
COLLECTOR CURRENT IC (mA)
1
10
10^2
10^3
10^4
10^5
1
10
100
1000
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE

2SD873

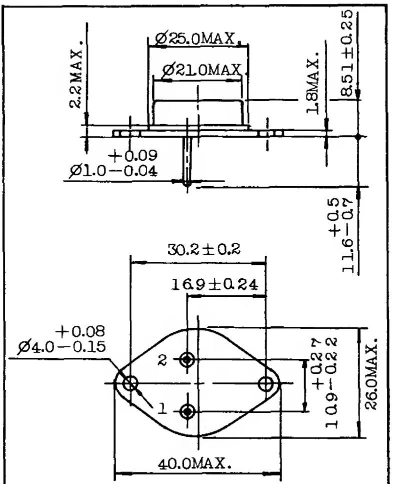
INDUSTRIAL APPLICATIONS.

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=150W (Tc=25°C)
- High Collector Current : I_C=16A
- Low Saturation Voltage : $V_{CE(sat)}$=0.4V(Typ.) (I_C=8A)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

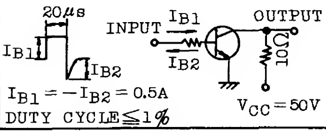
JEDEC	TO−204MA/TO−3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21D1A

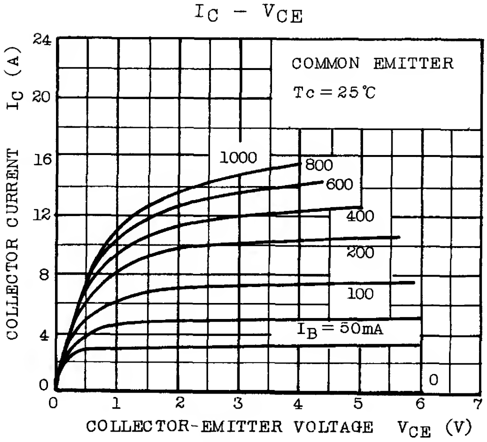
Mounting Kit No. AC73
Weight : 12.6g

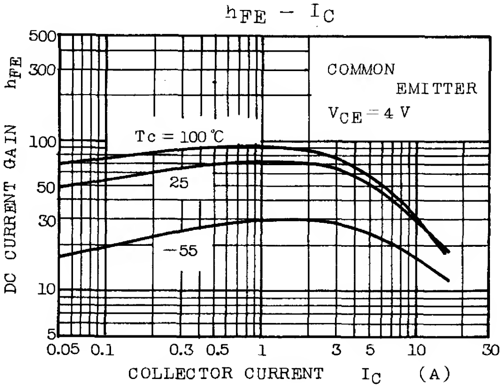
MAXIMUM RATINGS (Ta=25°C)

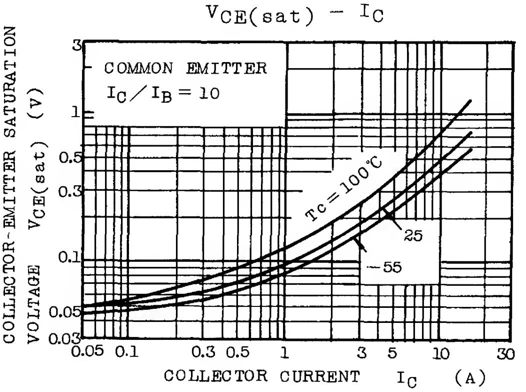
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	160	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	16	A
Base Current	I_B	4	A
Collector Power Dissipation (Tc=25°C)	P_C	150	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

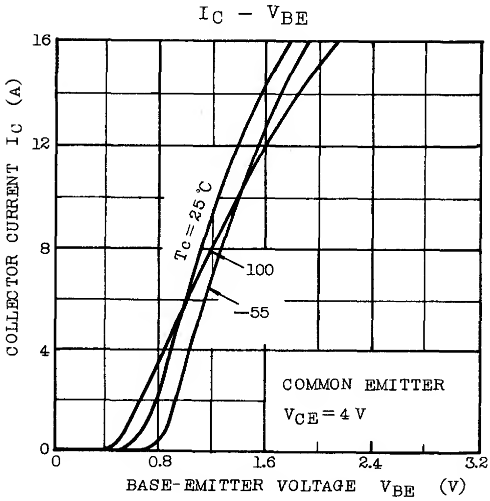
ELECTRICAL CHARACTERISTICS (Ta=25°C)

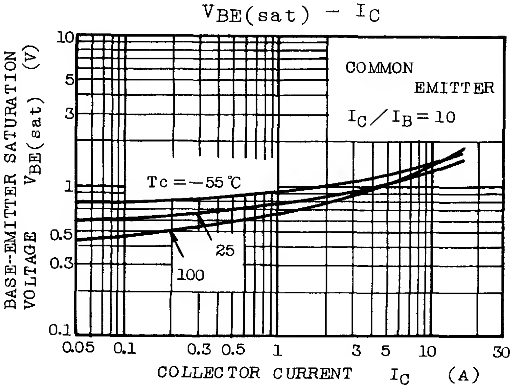
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=140V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	140	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=4V, I_C=8A	15	-	60	
		$h_{FE(2)}$	V_{CE}=4V, I_C=16A	5	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=8A, I_B=0.8A	-	0.4	1.4	V
Base-Emitter Voltage		V_{BE}	V_{CE}=4V, I_C=8A	-	1.2	2.2	V
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	350	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT IB1 OUTPUT IB1 IB2 IB2 10Ω IB1 = −IB2 = 0.5A DUTY CYCLE≦1% VCC=50V	-	2.5	-	μs
	Storage Time	t_{stg}		-	4.5	-	
	Fall Time	t_f		-	1.4	-	

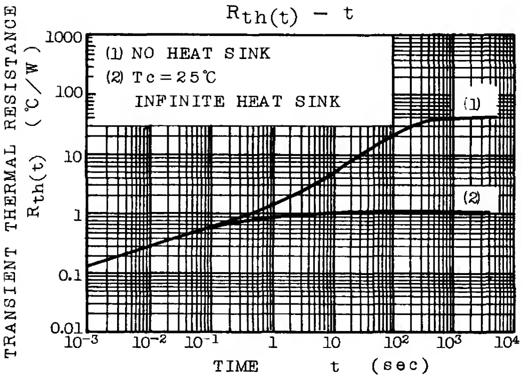

I_C – V_{CE}
COMMON EMITTER
Tc = 25 ℃
1000
800
600
400
200
100
I_B = 50mA
0
COLLECTOR CURRENT I_C (A)
0
4
8
12
16
20
24
0
1
2
3
4
5
6
7
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

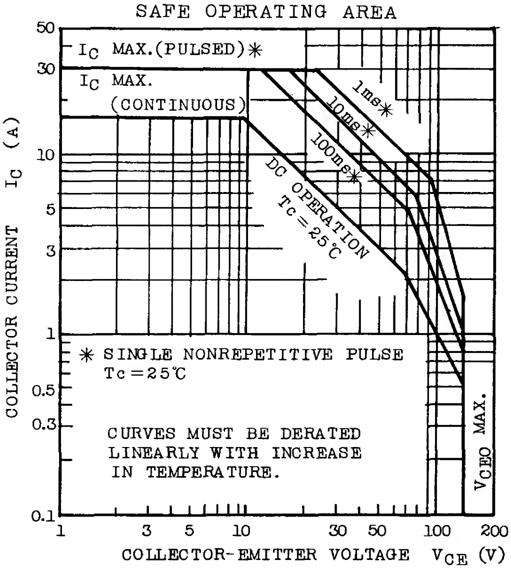

h_{FE} – I_C
COMMON EMITTER
V_{CE} = 4 V
Tc = 100 ℃
25
−55
DC CURRENT GAIN h_{FE}
5
10
30
50
100
300
500
0.05
0.1
0.3
0.5
1
3
5
10
30
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C / I_B = 10
Tc = 100 ℃
25
−55
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0.03
0.05
0.1
0.3
0.5
1
3
0.05
0.1
0.3
0.5
1
3
5
10
30
COLLECTOR CURRENT I_C (A)


I_C – V_{BE}
Tc = 25 ℃
100
−55
COMMON EMITTER
V_{CE} = 4 V
COLLECTOR CURRENT I_C (A)
0
4
8
12
16
0
0.8
1.6
2.4
3.2
BASE-EMITTER VOLTAGE V_{BE} (V)


$V_{BE(sat)}$ – I_C
COMMON EMITTER
I_C / I_B = 10
Tc = −55 ℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
0.1
0.3
0.5
1
3
5
10
0.05
0.1
0.3
0.5
1
3
5
10
30
COLLECTOR CURRENT I_C (A)


$R_{th(t)}$ – t
(1) NO HEAT SINK
(2) Tc = 25°C
INFINITE HEAT SINK
(1)
(2)
TRANSIENT THERMAL RESISTANCE $R_{th(t)}$ (°C/W)
1000
100
10
1
0.1
0.01
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
10^{3}
10^{4}
TIME t (sec)


SAFE OPERATING AREA
I_C MAX.(PULSED)✳
I_C MAX. (CONTINUOUS)
1ms✳
10ms✳
100ms✳
DC OPERATION Tc = 25°C
✳ SINGLE NONREPETITIVE PULSE Tc = 25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
50
30
10
5
3
1
0.5
0.3
0.1
1
3
5
10
30
50
100
200
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

2SD877

SILICON NPN TRIPLE DIFFUSED TYPE

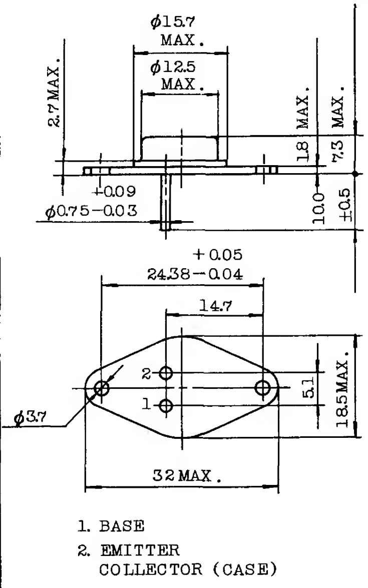
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- Low Saturation Voltage : $V_{CE(sat)}=0.5V$ (Typ.) ($I_C=3A$)



1. BASE
2. EMITTER
COLLECTOR (CASE)

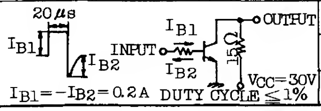
JEDEC	TO−66
EIAJ	TC−16A, TB−23
TOSHIBA	2−13A1A

Mounting kit No. AC74
Weight : 5.9g

MAXIMUM RATINGS (Ta=25°C)

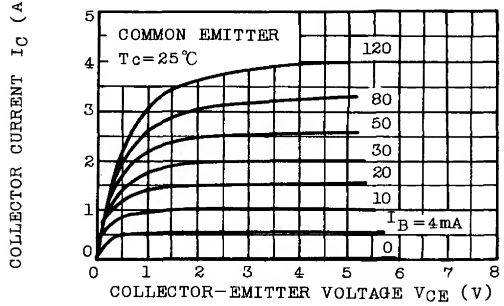
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	110	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	3	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65∿175	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

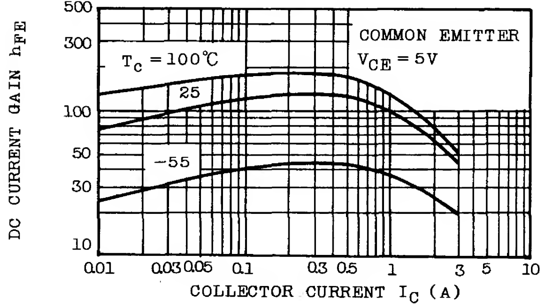
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=110V$, $I_E=0$	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	−	−	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	80	−	−	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V$, $I_C=0.5A$ (Note)	60	−	300	
		$h_{FE(2)}$	$V_{CE}=5V$, $I_C=2.5A$	20	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A$, $I_B=0.3A$	−	0.5	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		−	1.2	1.5	
Transition Frequency		f_T	$V_{CE}=5V$, $I_E=-0.5A$	−	3	−	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	−	85	−	PF
Switching Time	Turn-on Time	t_{on}	 20μs IB1 IB2 INPUT OUTPUT IB1 IB2 15Ω VCC=30V IB1=−IB2=0.2A DUTY CYCLE ≤1%	−	1.5	−	us
	Storage Time	t_{stg}		−	5.0	−	
	Fall Time	t_f		−	2.0	−	

Note : h_{FE} Classification : 0 : 60∿120, Y : 100∿200, GR : 150∿300

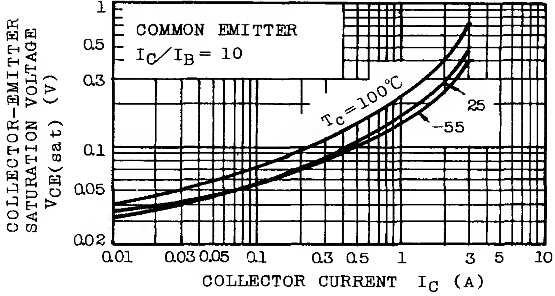
IC — VCE



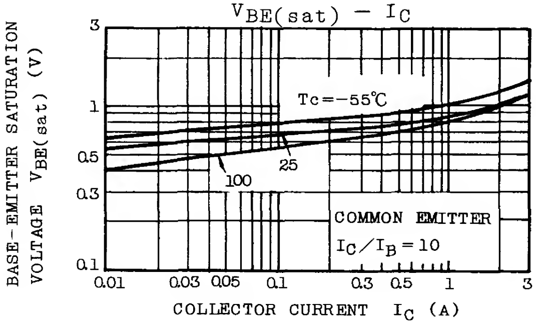
hFE — IC



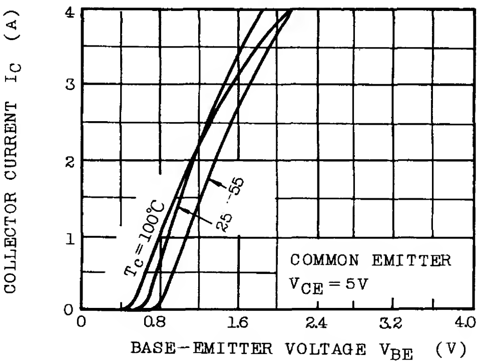
VCE(sat) — IC



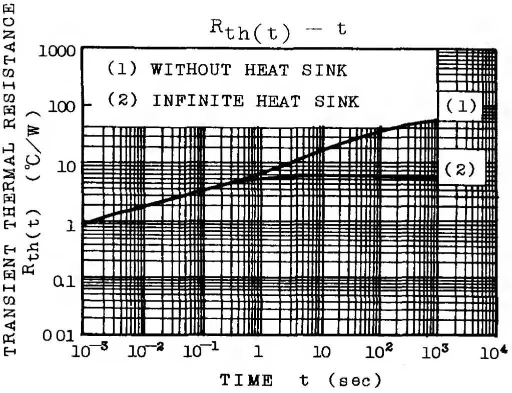
VBE(sat) — IC



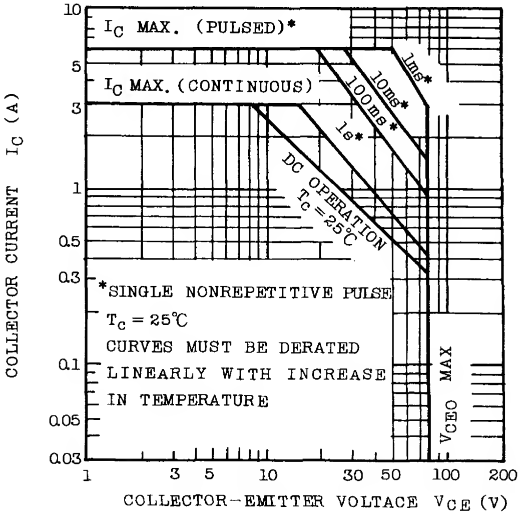
IC — VBE



Rth(t) — t



SAFE OPERATING AREA



2SD878

SILICON NPN TRIPLE DIFFUSED TYPE

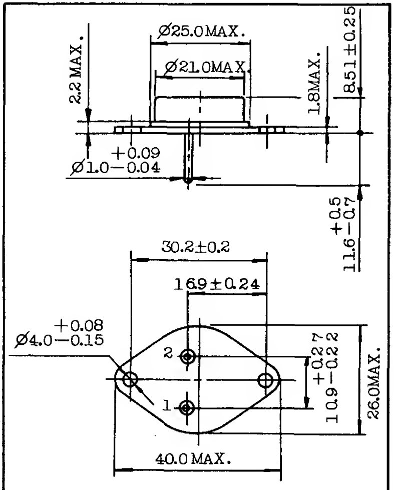
HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=115W (Tc=25°C)
- High Collector Current : I_C=15A
- Low Saturation Voltage : $V_{CE(sat)}$=0.3V (Typ.)(I_C=4A)

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

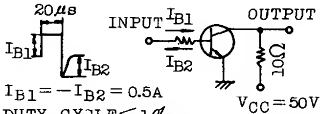
JEDEC	TO−204MA/TO−3
EIAJ	TC − 3, TB − 3
TOSHIBA	2 − 21D1A

Mounting Kit No. AC73
Weight : 12.6g

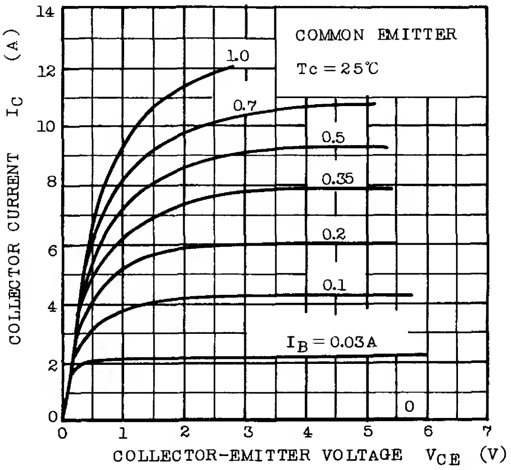
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	60	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	15	A
Base Current	I_B	7	A
Collector Power Dissipation (Tc=25°C)	P_C	115	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65∿175	°C

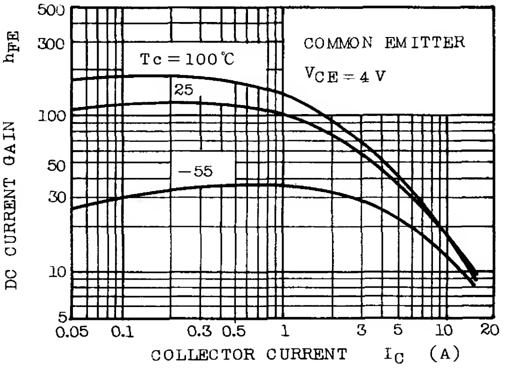
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	60	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=4V, I_C=4A	20	-	70	
		$h_{FE(2)}$	V_{CE}=4V, I_C=10A	5	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	0.3	1.1	V
Base-Emitter Voltage		V_{BE}	V_{CE}=4V, I_C=4A	-	1.1	1.8	V
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω V_{CC}=50V	-	2.5	-	μs
	Storage Time	t_{stg}		-	3.5	-	
	Fall Time	t_f	I_{B1}=−I_{B2}=0.5A DUTY CYCLE≦1%	-	1.2	-	

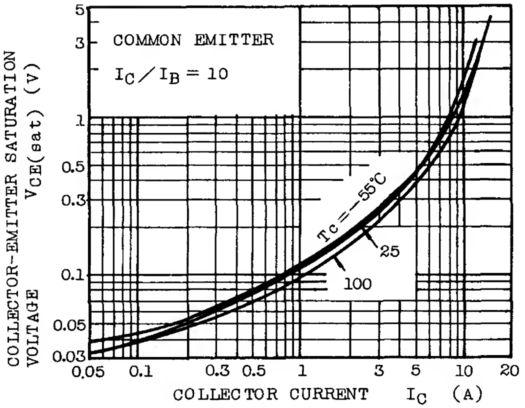
$I_C - V_{CE}$



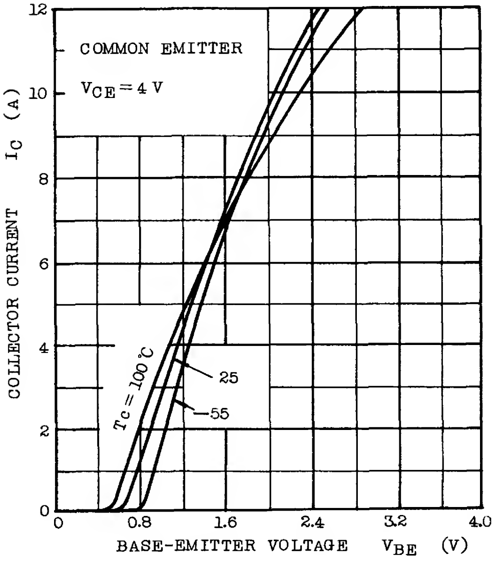
$h_{FE} - I_C$



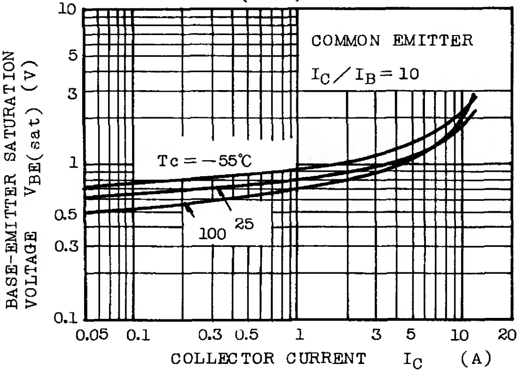
$V_{CE(sat)} - I_C$

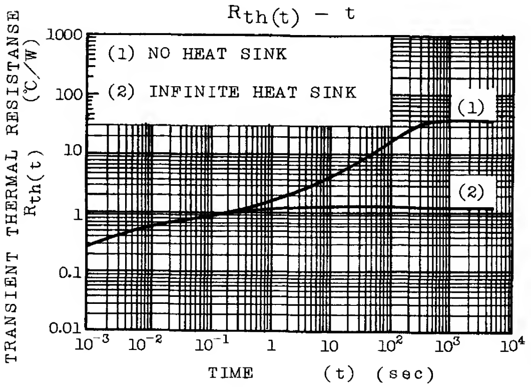


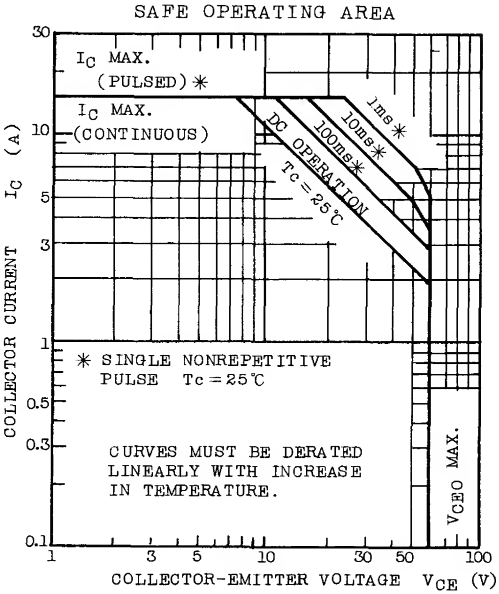
$I_C - V_{BE}$



$V_{BE(sat)} - I_C$




Rth(t) – t
TRANSIENT THERMAL RESISTANSE Rth(t) (℃/W)
1000
100
10
1
0.1
0.01
(1) NO HEAT SINK
(2) INFINITE HEAT SINK
(1)
(2)
10⁻³
10⁻²
10⁻¹
1
10
10²
10³
10⁴
TIME (t) (sec)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
30
10
5
3
1
0.5
0.3
0.1
IC MAX. (PULSED) ✳
IC MAX. (CONTINUOUS)
1ms✳
10ms✳
100ms✳
DC OPERATION
Tc = 25℃
✳ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
VCEO MAX.
1
3
5
10
30
50
100
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE

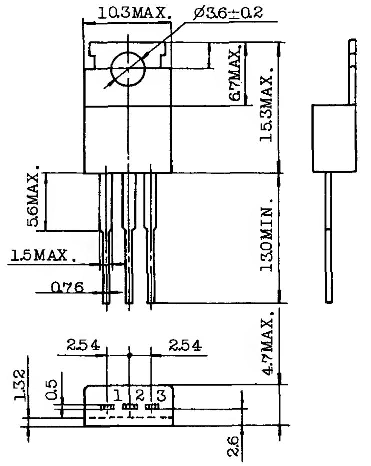
2SD880

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- High DC Current Gain
  : h_{FE}=300(Max.)(V_{CE}=5V, I_C=0.5A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.0V(Max.)(I_C=3A, I_B=0.3A)
- High Power Dissipation : P_C=30W (Tc=25°C)
- Complementary to 2SB834.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

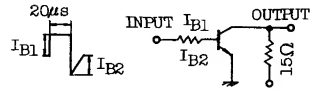
JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

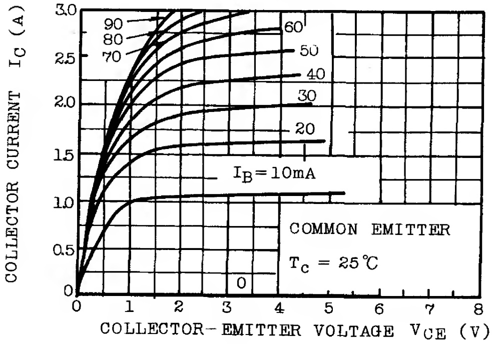
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	T_j	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55∿150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

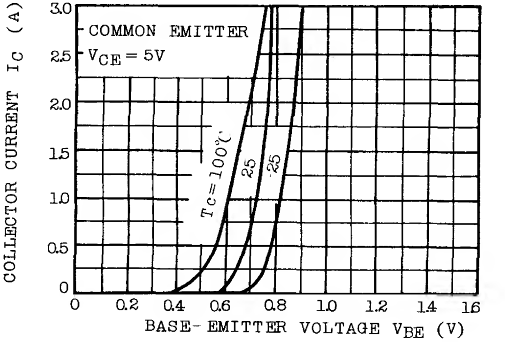
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	60	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.5A (Note)	60	-	300	
Collector Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	3.0	-	MHz
Collector Output Capacitance		C_{cb}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 15Ω 30V I_{B1}=−I_{B2}=0.2A DUTY CYCLE < 1%	-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

Note: h_{FE} Classification 60∿120, Y : 100∿200, GR: 150∿300.

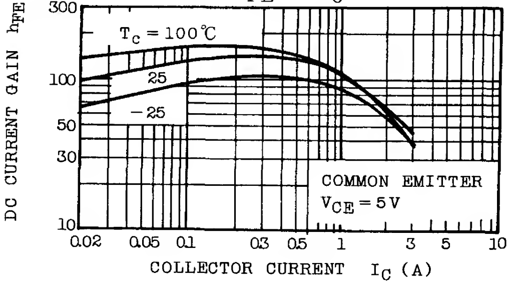
I_C - V_{CE}



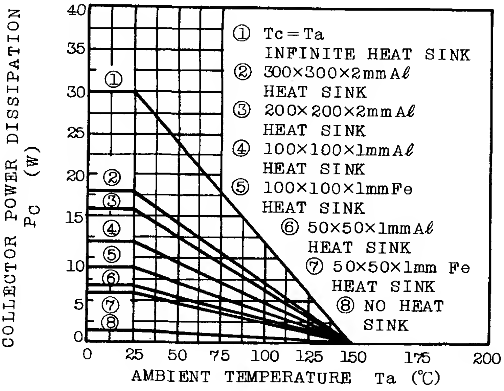
I_C — V_{BE}



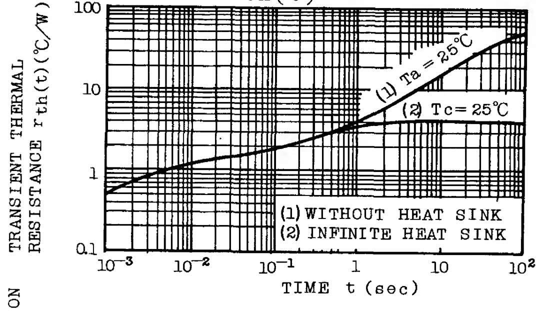
h_{FE} — I_C



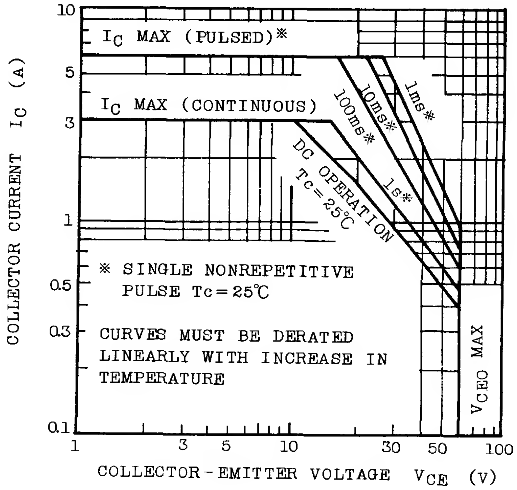
P_C - Ta



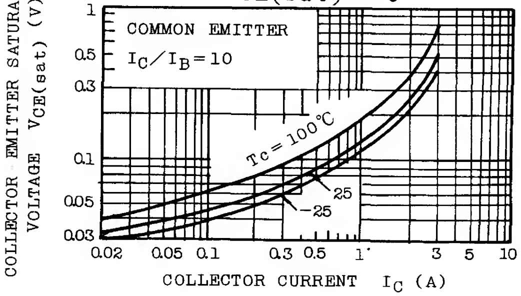
$r_{th}(t)$ - t



SAFE OPERATING AREA



$V_{CE(sat)}$ - I_C



SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

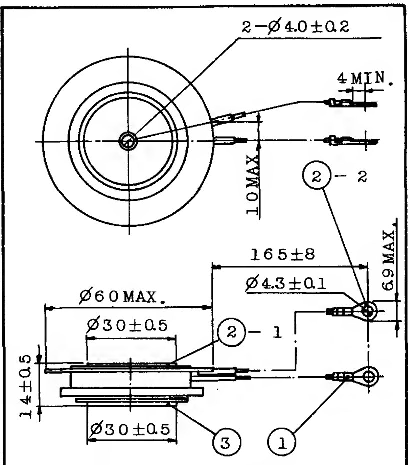
2SD1034A

HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- High Voltage : $V_{CEO(SUS)}=450V$
- Triple Diffused Design.
- Darlington Design.

INDUSTRIAL APPLICATION
Unit in mm



① BASE (WHITE)
②-1 EMITTER
②-2 EMITTER (RED)
③ COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2-60B1A

Weight : 150g

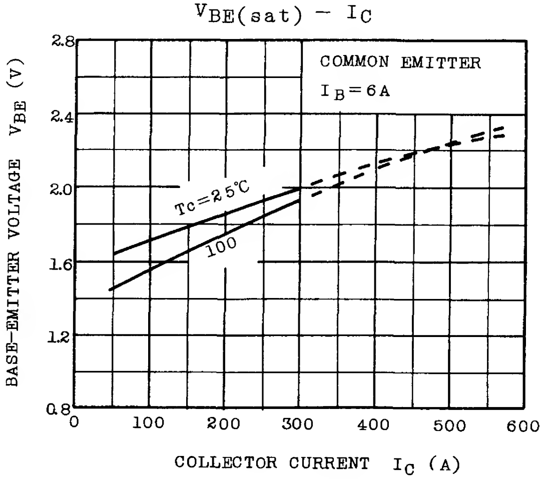
MAXIMUM RATINGS (Ta=25°C)

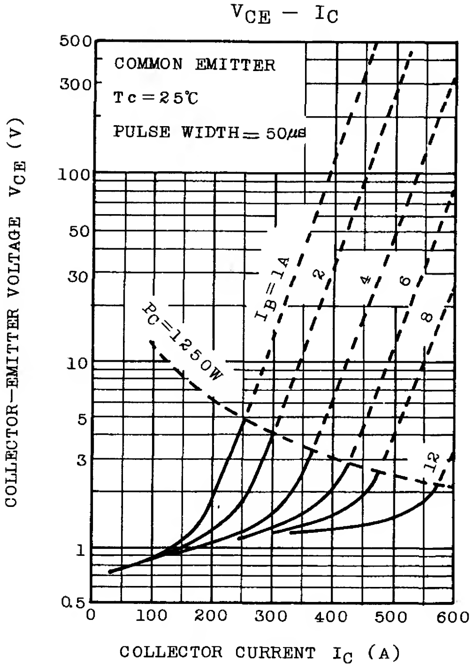
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	300	A
Emitter Current	I_E	-300	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.08	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	-40～150	°C
Mounting Force Required	F	500±50	kg

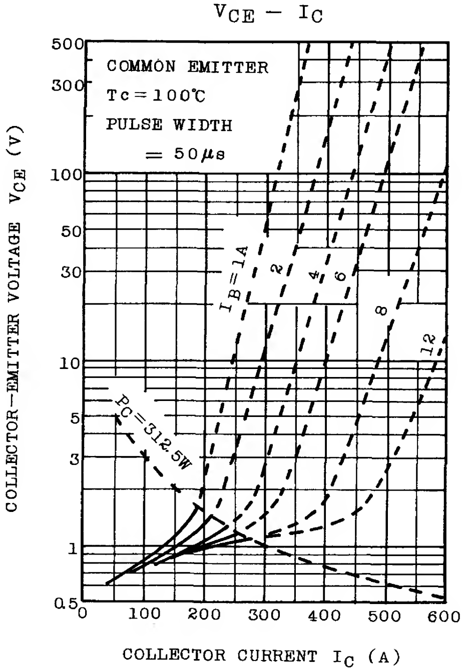
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=300A$	150	-	-	
			$V_{CE}=5V$, $I_C=150A$	-	500	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	450	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=300A$, $I_B=6A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V$, $I_E=0$	-	-	2	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V$, $I_C=0$	-	-	600	mA
Switching Time	Turn-on Time	t_{on}	$I_C=300A$, $I_{B1}=6A$, $-I_{B2}=16A$, $V_C=300V$	-	1	2	μs
	Storage Time	t_{stg}		-	13	16	
	Fall Time	t_f		-	2.5	4	

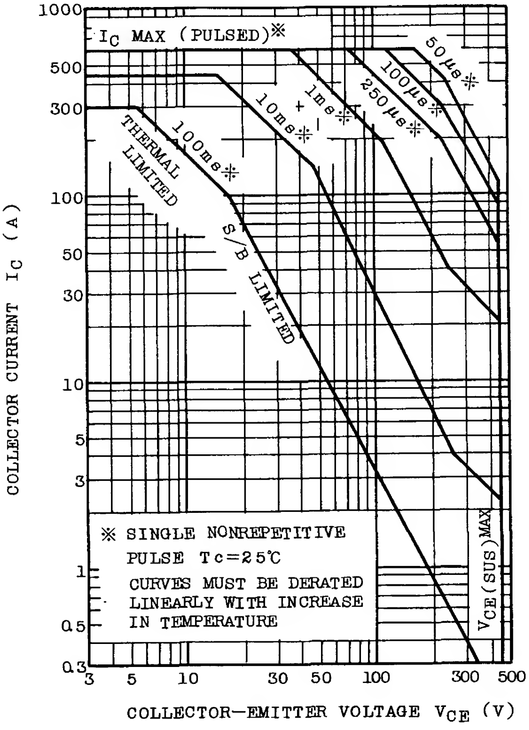
Note : Pulse Test; Pulse width≦300μs, Duty Cycle≦3%
Mounting Force; F=500kg


$V_{BE(sat)}$ − I_C
COMMON EMITTER
I_B=6A
Tc=25℃
100
BASE-EMITTER VOLTAGE V_{BE} (V)
2.8
2.4
2.0
1.6
1.2
0.8
0
100
200
300
400
500
600
COLLECTOR CURRENT I_C (A)

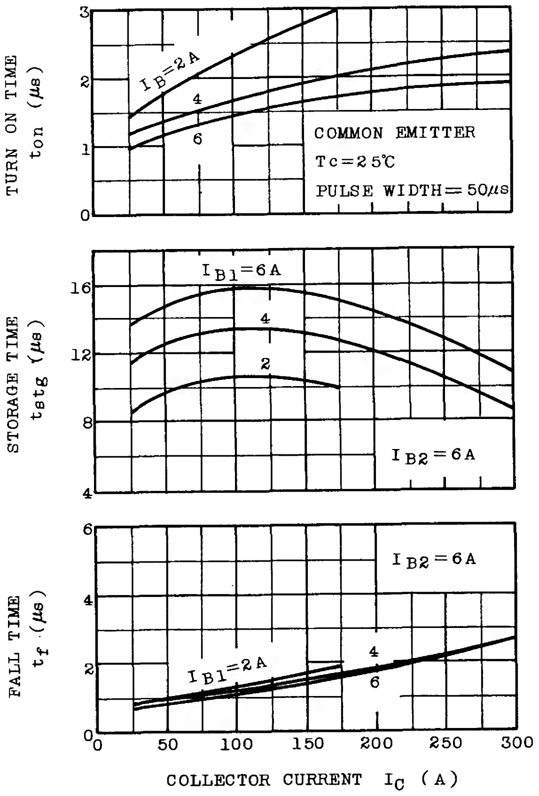

V_{CE} − I_C
COMMON EMITTER
Tc=25℃
PULSE WIDTH=50μs
I_B=1A
2
4
6
8
12
P_C=1250W
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
500
300
100
50
30
10
5
3
1
0.5
0
100
200
300
400
500
600
COLLECTOR CURRENT I_C (A)


V_{CE} − I_C
COMMON EMITTER
Tc=100℃
PULSE WIDTH
=50μs
I_B=1A
2
4
6
8
12
P_C=312.5W
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
500
300
100
50
30
10
5
3
1
0.5
0
100
200
300
400
500
600
COLLECTOR CURRENT I_C (A)

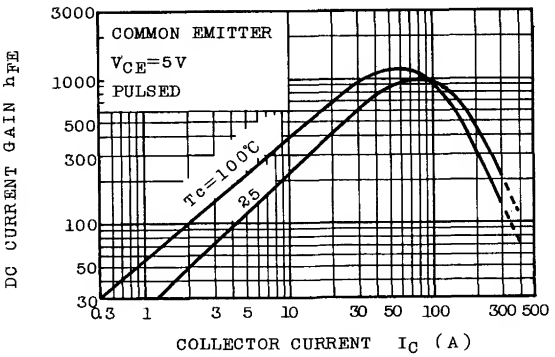
SAFE OPERATING AREA



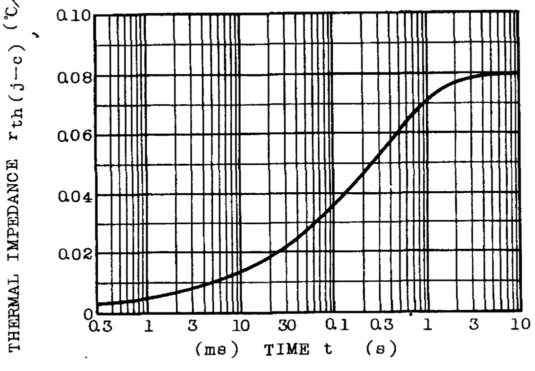
SWITCHING TIME – IC



hFE – IC



TRANSIENT THERMAL IMPEDANCE (JUNCTION – TO)



2SD1052

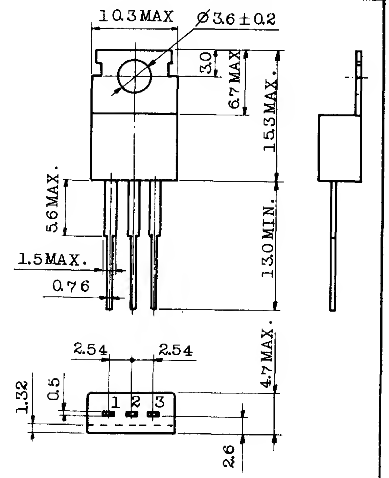
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- High DC Current Gain of 250 to 750 at V_{CE}=5V, I_C=0.5A
- Low $V_{CE(sat)}$ of 1.0V (MAX.) at I_C=1A, I_B=0.02A
- Collector Power Dissipation of 30W at Tc=25°C

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

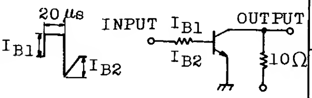
JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

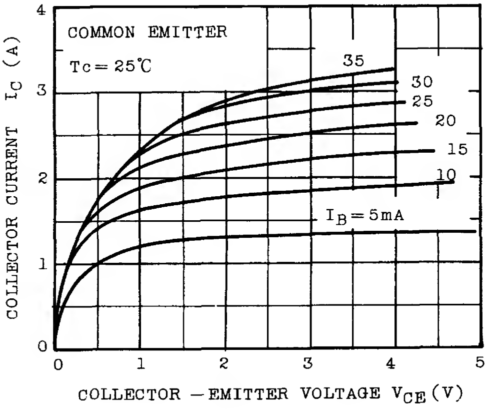
Mounting kit No.AC75
Weight : 1.9g

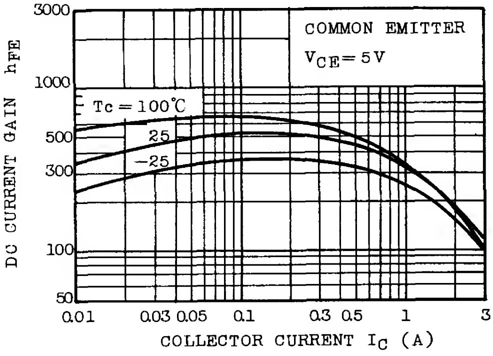
MAXIMUM RATINGS (Ta=25°C)

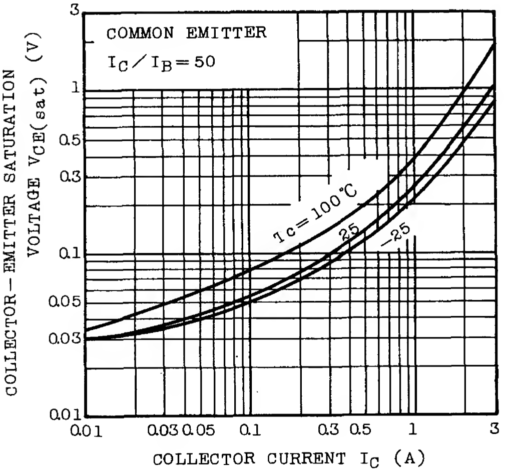
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-55~150	°C

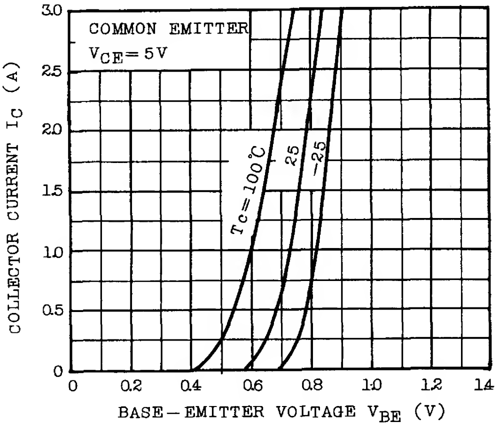
ELECTRICAL CHARACTERISTICS (Ta=25°C)

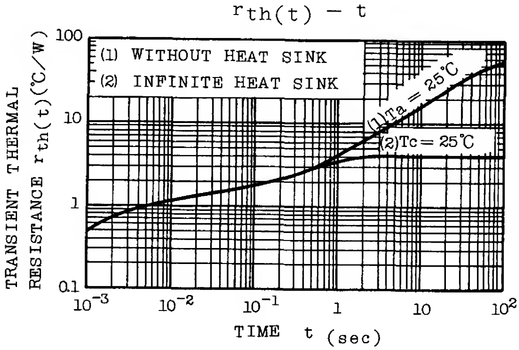
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.5A	250	-	750	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1.0A, I_B=0.02A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	5.0	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	T_{on}	 20μs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 10Ω 10V I_{B1}=10mA I_{B2}=−20mA DUTY CYCLE<1%	-	1.5	-	μs
	Storage Time	T_{stg}		-	4.5	-	
	Fall Time	T_f		-	3.0	-	

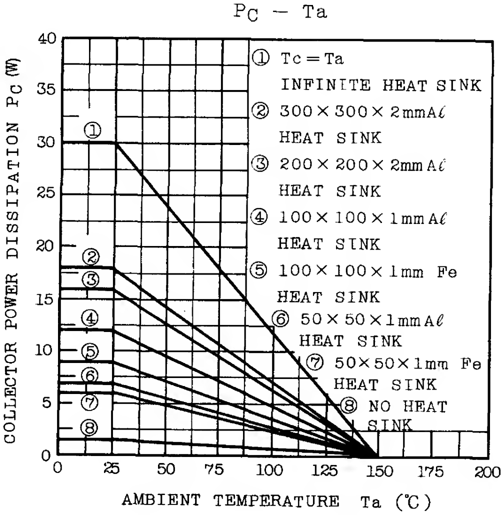

$I_C - V_{CE}$

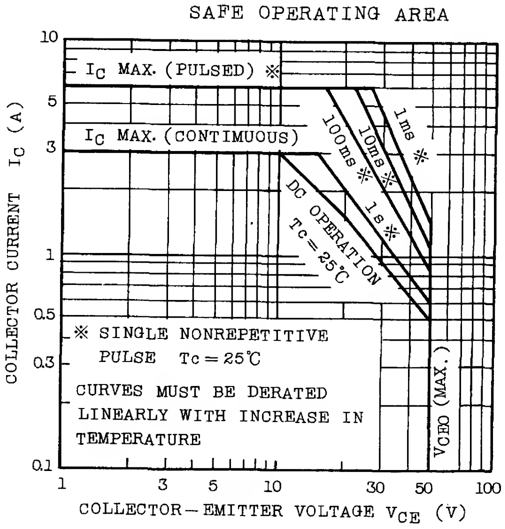

$h_{FE} - I_C$


$V_{CE(sat)} - I_C$


$I_C - V_{BE}$


rth(t) − t
TRANSIENT THERMAL RESISTANCE rth(t)(℃/W)
100
10
1
0.1
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1)Ta = 25℃
(2)Tc = 25℃
10⁻³
10⁻²
10⁻¹
1
10
10²
TIME t (sec)


PC − Ta
COLLECTOR POWER DISSIPATION PC (W)
40
35
30
25
20
15
10
5
0
① Tc = Ta INFINITE HEAT SINK
② 300 × 300 × 2mmAℓ HEAT SINK
③ 200 × 200 × 2mmAℓ HEAT SINK
④ 100 × 100 × 1mmAℓ HEAT SINK
⑤ 100 × 100 × 1mm Fe HEAT SINK
⑥ 50 × 50 × 1mmAℓ HEAT SINK
⑦ 50×50×1mm Fe HEAT SINK
⑧ NO HEAT SINK
①
②
③
④
⑤
⑥
⑦
⑧
0
25
50
75
100
125
150
175
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
IC MAX. (PULSED) ※
IC MAX. (CONTIMUOUS)
1ms ※
10ms ※
100ms ※
1s ※
DC OPERATION Tc = 25℃
VCEO (MAX.)
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
1
3
5
10
30
50
100
COLLECTOR − EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

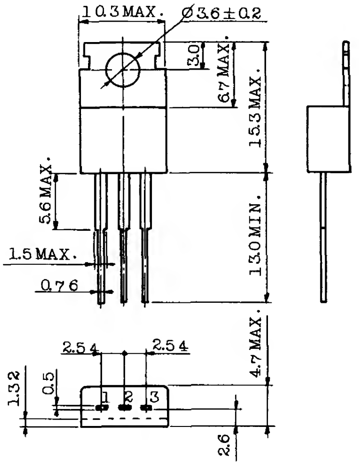
2SD1052A

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- High DC Current Gain of 400 to 1200 at V_{CE}=5V, I_C=0.5A
- Low $V_{CE(sat)}$ of 1.0V (MAX.) at I_C=1A, I_B=0.02A
- Collector Power Dissipation of 30W at Tc=25°C

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

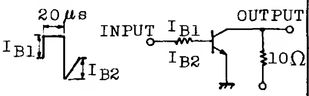
Mounting kit No.AC75

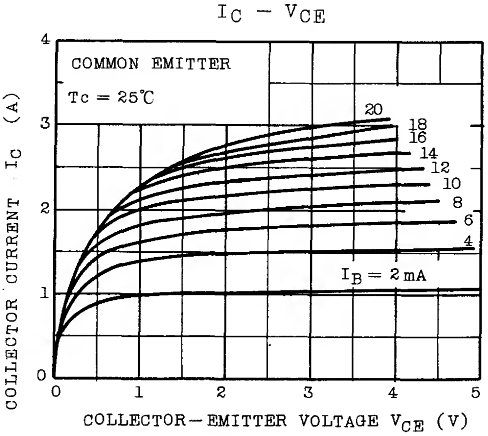
Weight : 1.9g

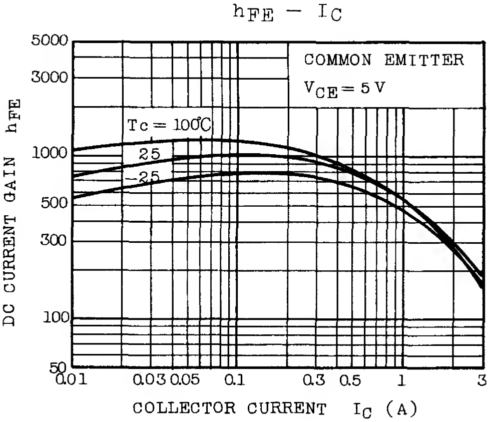
MAXIMUM RATINGS (Ta=25°C)

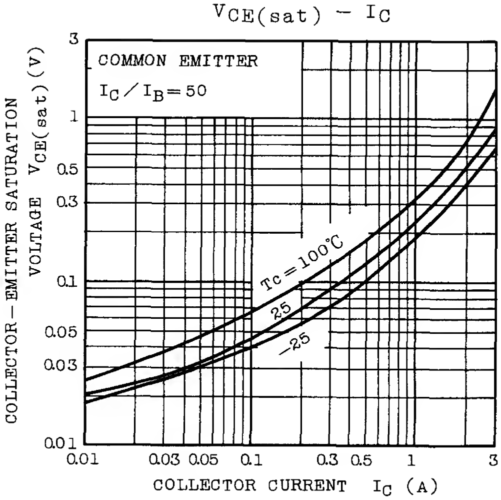
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55~150	°C

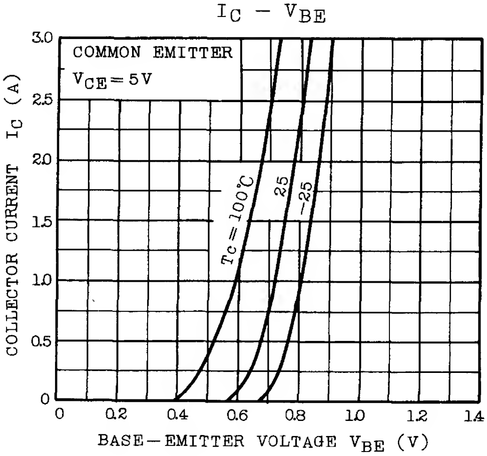
ELECTRICAL CHARACTERISTICS (Ta=25°C)

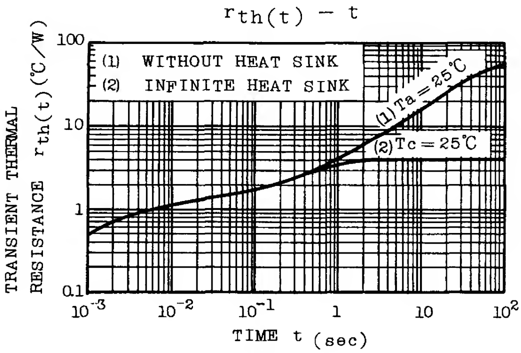
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	−	−	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	−	−	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.5A	400	−	1200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.02A	−	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	−	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	−	5.0	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	70	−	pF
Switching Time	Turn-on Time	T_{on}	 20μs INPUT I_{B1} OUTPUT I_{B1} I_{B2} I_{B2} 10Ω 10V I_{B1}=10mA I_{B2}=−20mA DUTY CYCLL <1%	−	2.0	−	μs
	Storage Time	T_{stg}		−	5.0	−	
	Fall Time	T_f		−	3.0	−	


IC − VCE
COMMON EMITTER
Tc = 25°C
20
18
16
14
12
10
8
6
4
IB = 2 mA
COLLECTOR CURRENT IC (A)
0
1
2
3
4
COLLECTOR−EMITTER VOLTAGE VCE (V)
0
1
2
3
4
5

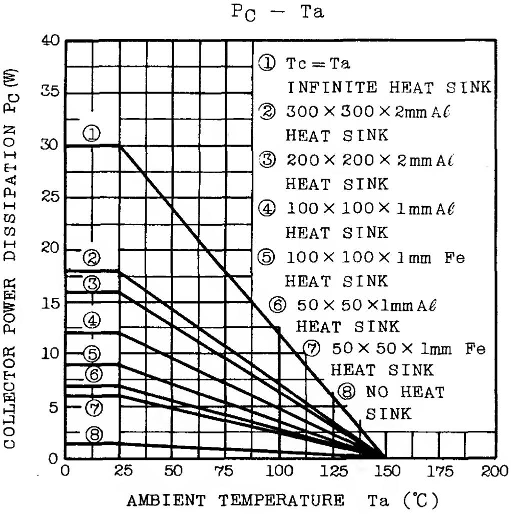

hFE − IC
COMMON EMITTER
VCE = 5 V
Tc = 100°C
25
−25
DC CURRENT GAIN hFE
5000
3000
1000
500
300
100
50
0.01
0.03
0.05
0.1
0.3
0.5
1
3
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC / IB = 50
Tc = 100°C
25
−25
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.01
0.03
0.05
0.1
0.3
0.5
1
3
COLLECTOR CURRENT IC (A)

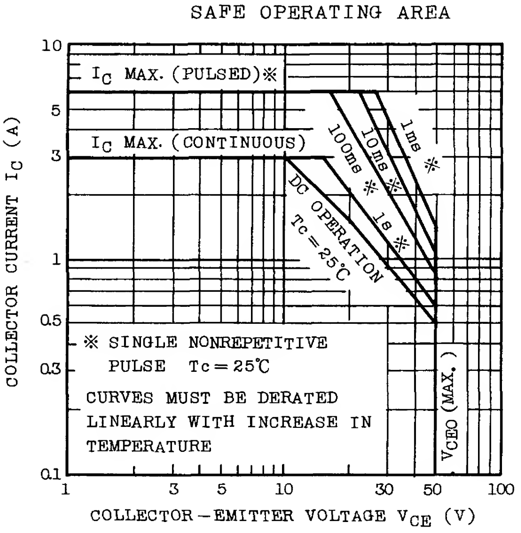

IC − VBE
COMMON EMITTER
VCE = 5 V
Tc = 100°C
25
−25
COLLECTOR CURRENT IC (A)
3.0
2.5
2.0
1.5
1.0
0.5
0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE−EMITTER VOLTAGE VBE (V)



$r_{th(t)} - t$
TRANSIENT THERMAL RESISTANCE $r_{th(t)}$ (℃/W)
100
10
1
0.1
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1) Ta = 25℃
(2) Tc = 25℃
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
TIME t (sec)



$P_C - Ta$
COLLECTOR POWER DISSIPATION P_C (W)
40
35
30
25
20
15
10
5
0
① Tc = Ta INFINITE HEAT SINK
② 300 × 300 × 2mm Al HEAT SINK
③ 200 × 200 × 2mm Al HEAT SINK
④ 100 × 100 × 1mm Al HEAT SINK
⑤ 100 × 100 × 1mm Fe HEAT SINK
⑥ 50 × 50 × 1mm Al HEAT SINK
⑦ 50 × 50 × 1mm Fe HEAT SINK
⑧ NO HEAT SINK
①
②
③
④
⑤
⑥
⑦
⑧
0
25
50
75
100
125
150
175
200
AMBIENT TEMPERATURE Ta (℃)



SAFE OPERATING AREA
COLLECTOR CURRENT I_C (A)
10
5
3
1
0.5
0.3
0.1
I_C MAX. (PULSED)※
I_C MAX. (CONTINUOUS)
1ms ※
10ms ※
100ms ※
1s ※
DC OPERATION
Tc = 25℃
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} (MAX.)
1
3
5
10
30
50
100
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

2SD1069

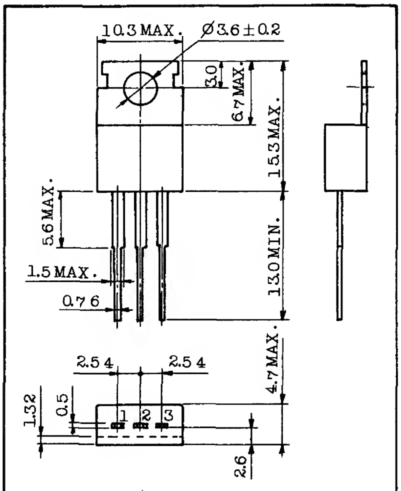
SILICON NPN DOUBLE DIFFUSED TYPE (PCT PROCESS)

TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- Built in Damper Type.
- High Collector Current Capability.
- High Collector Power Dissipation Capability.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

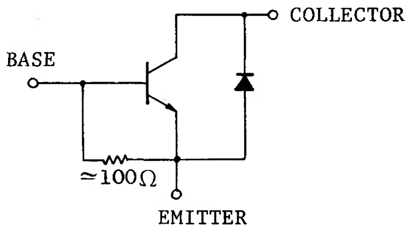
Mounting kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	150	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	7	A
Collector Current (Peak)		I_{CP}	15	A
Base Current		I_{BM}	2	A
Collector Power Dissipation	Ta=25°C	P_C	1.75	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

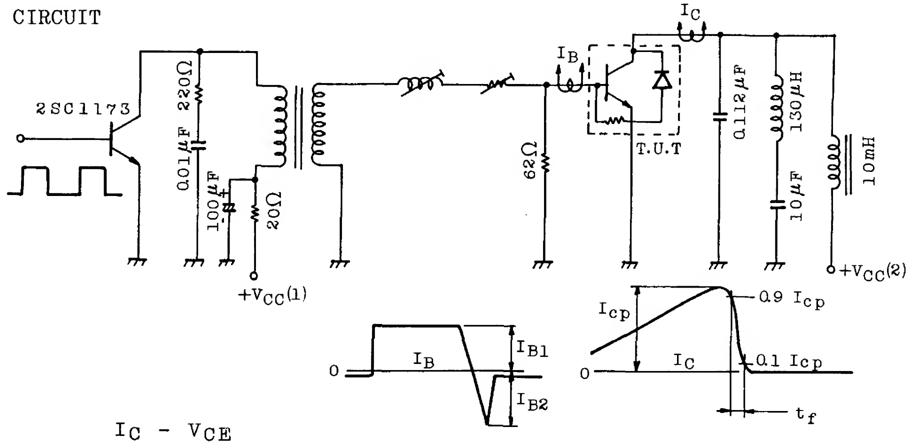
EQUIVALENT CIRCUIT



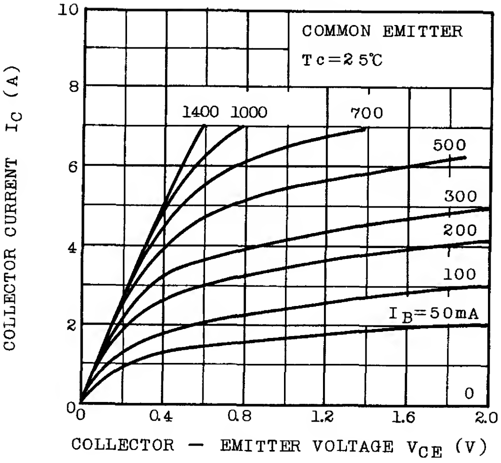
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	V_{CE}=250V, V_{BE}=0	-	-	1.0	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	I_C=0.1A, L=50mH	150	-	-	V
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	300	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	I_E=0.1A, I_C=0	6	-	-	V
DC Forward Current Transfer Ratio	h_{FE}	V_{CE}=1.5V, I_C=5A	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
Damper Diode Forward Voltage	$-V_F$	I_C=-6A	-	-	1.8	V
Collector Current Fall Time	t_f	I_{cp}=5A, $I_{B1(end)}$=0.5A	-	-	1.0	μs
Transition Frequency	f_T	V_{CE}=10V, I_C=0.2A	-	18	-	MHz

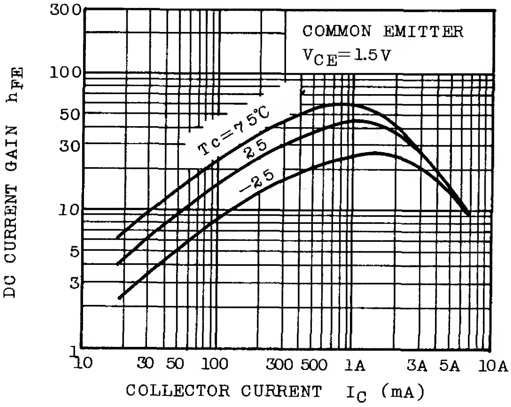
TEST CIRCUIT



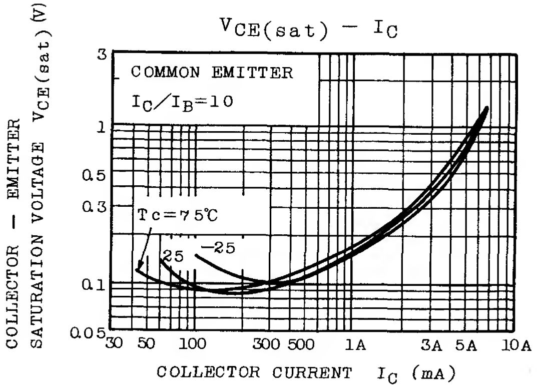
I_C – V_{CE}



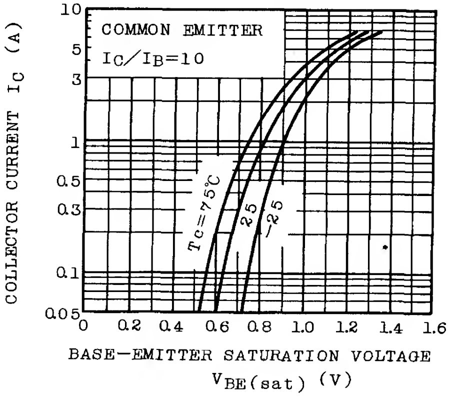
h_{FE} – I_C

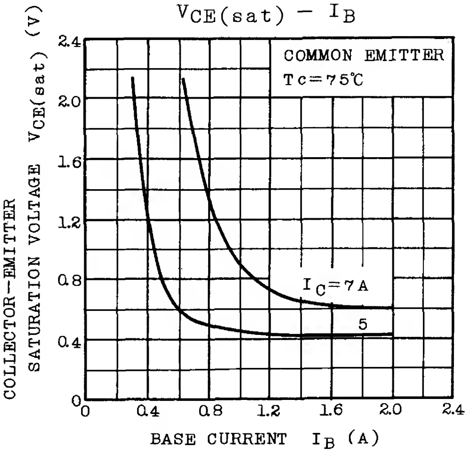


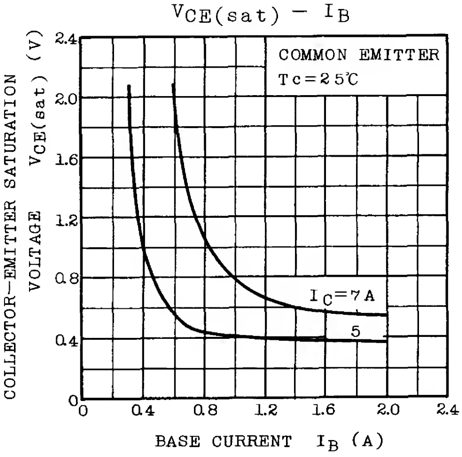
$V_{CE(sat)}$ – I_C

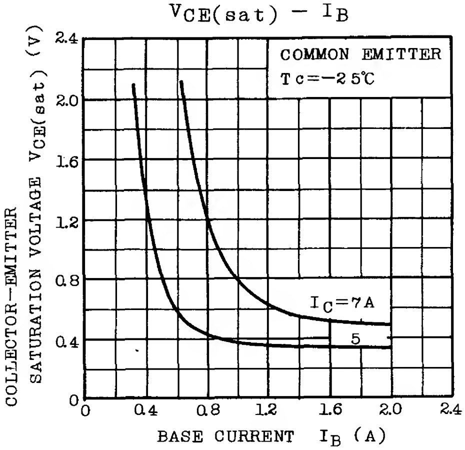


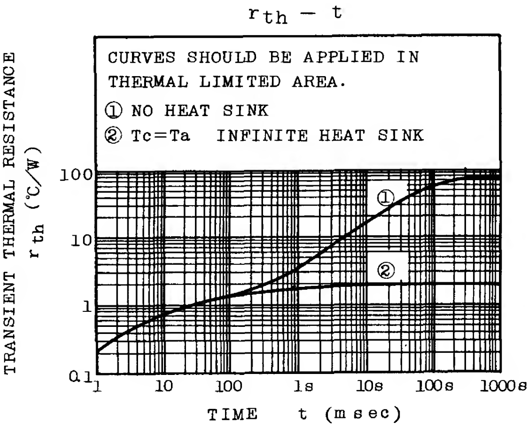
I_C – $V_{BE(sat)}$

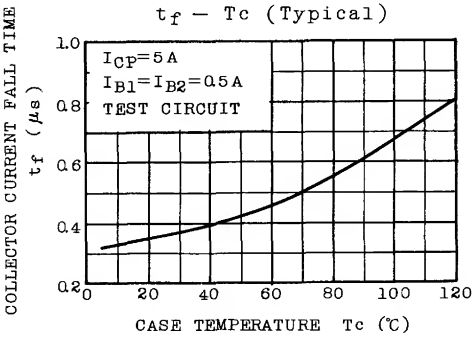



VCE(sat) − IB
COMMON EMITTER
Tc=75℃
IC=7A
5
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT IB (A)


VCE(sat) − IB
COMMON EMITTER
Tc=25℃
IC=7A
5
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT IB (A)


VCE(sat) − IB
COMMON EMITTER
Tc=−25℃
IC=7A
5
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT IB (A)


rth − t
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA.
① NO HEAT SINK
② Tc=Ta INFINITE HEAT SINK
①
②
TRANSIENT THERMAL RESISTANCE rth (℃/W)
100
10
1
0.1
1
10
100
1s
10s
100s
1000s
TIME t (msec)


tf − Tc (Typical)
ICP=5A
IB1=IB2=0.5A
TEST CIRCUIT
COLLECTOR CURRENT FALL TIME tf (μs)
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80
100
120
CASE TEMPERATURE Tc (℃)

2SD1087

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

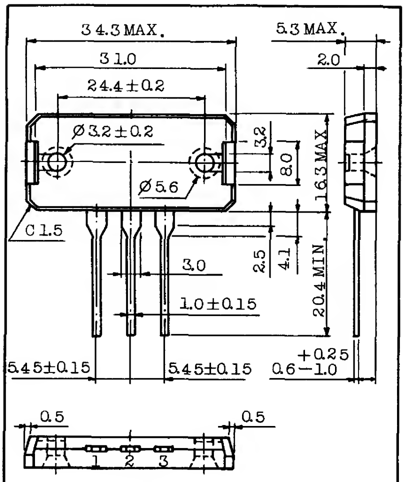
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES

- High DC Current Gain
  : h_{FE}=1000(Min.) (V_{CE}=3V, I_C=15A)
- Low Collector Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=15A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

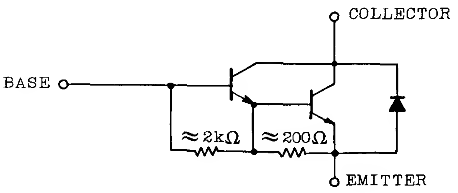
JEDEC	−
EIAJ	−
TOSHIBA	2−34A1A

Weight : 10.8g

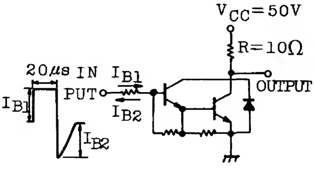
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	1	A
Collector Power Disipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

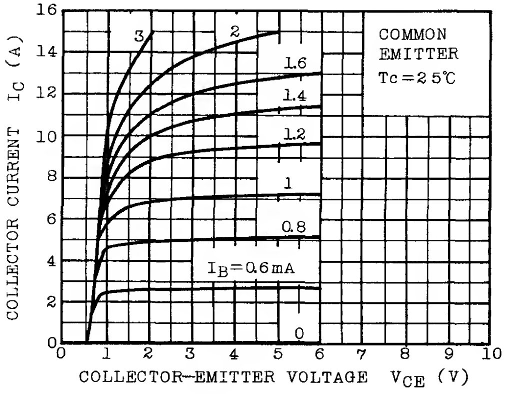
EQUIVALENT CIRCUIT



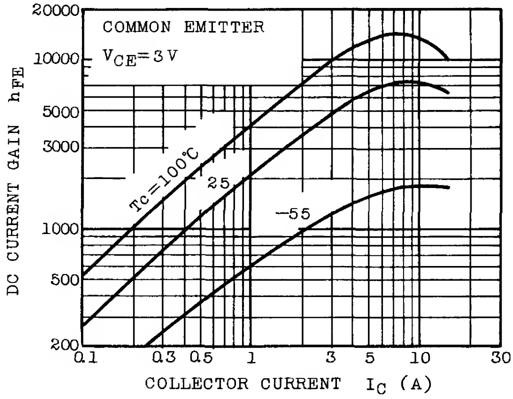
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V$, $I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	10	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	100	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=3V$, $I_C=15A$	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=15A$, $I_B=0.025A$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.2	V
Emitter-Collector Forward Voltage		V_{ECF}	$I_E=10A$, $I_B=0$	-	-	3	V
Transition Frequency		f_T	$V_{CE}=5V$, $I_C=1A$	-	14	-	MHz
Collecotr Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	-	280	-	pF
Switching Time	Turn-on Time	t_{on}	 $V_{CC}=50V$ R=10Ω 20μs INPUT I_{B1} I_{B2} OUTPUT $I_{B1}=-I_{B2}=0.01A$ DUTY CYCLE≦1%	-	0.7	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	2.5	-	

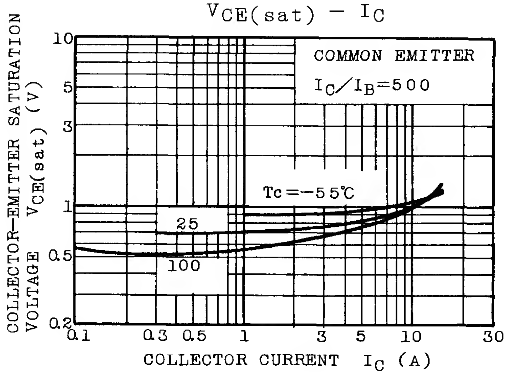
I_C – V_{CE}



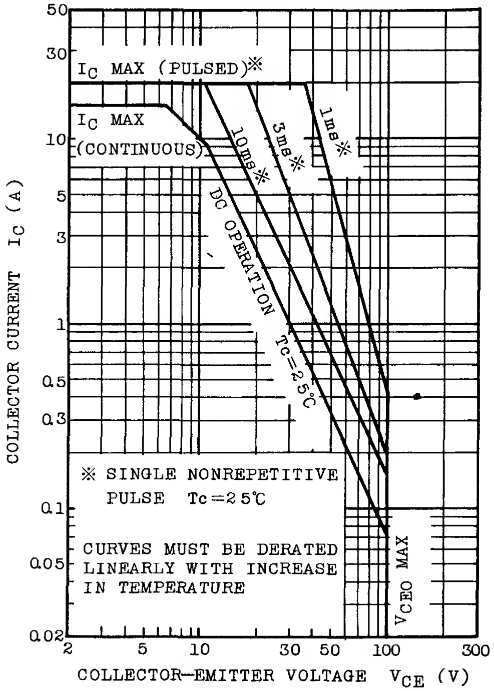
h_{FE} – I_C



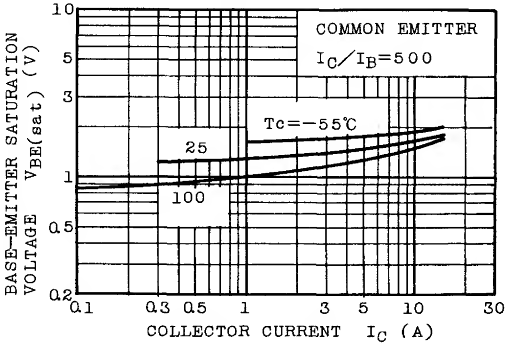
$V_{CE(sat)}$ – I_C



SAFE OPERATING AREA



$V_{BE(sat)}$ – I_C



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD1088

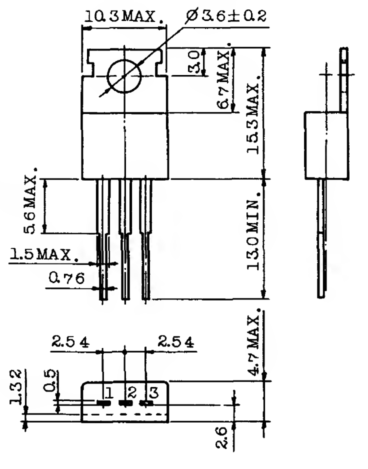
INDUSTRIAL APPLICATIONS

IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000(Min.) (V_{CE}=2V, I_C=2A)

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

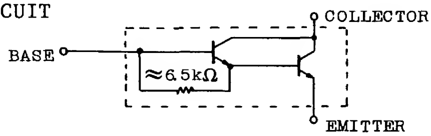
JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting kit No. AC75
Weight : 1.9g

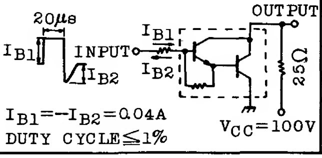
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

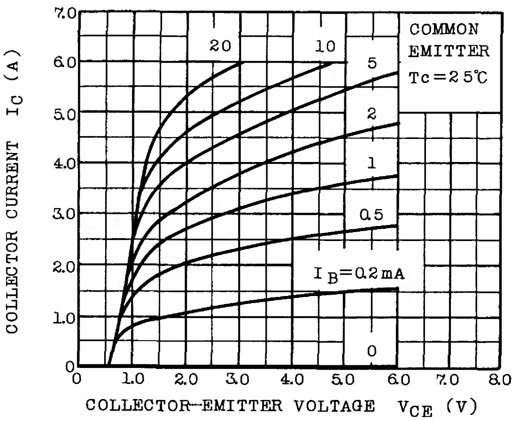
EQUIVALENT CIRCUIT



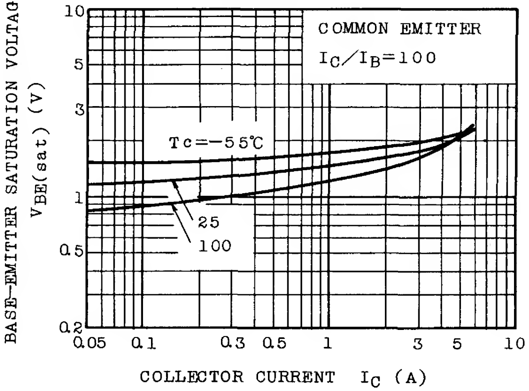
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=300V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	250	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 OUTPUT 20μs I_{B1} I_{B1} INPUT I_{B2} I_{B2} 25Ω I_{B1}=−I_{B2}=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

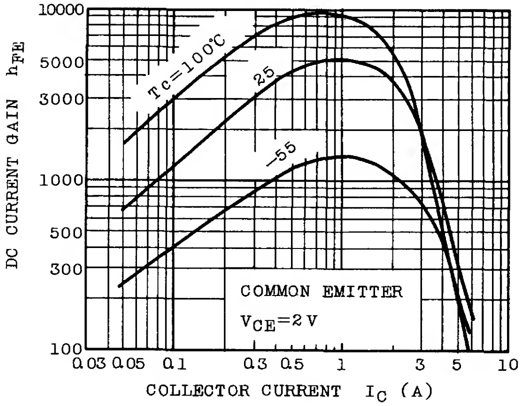
$I_C - V_{CE}$



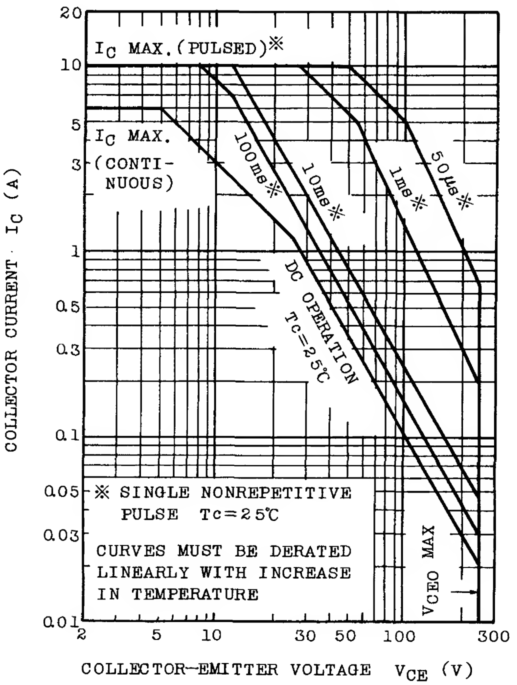
$V_{BE(sat)} - I_C$



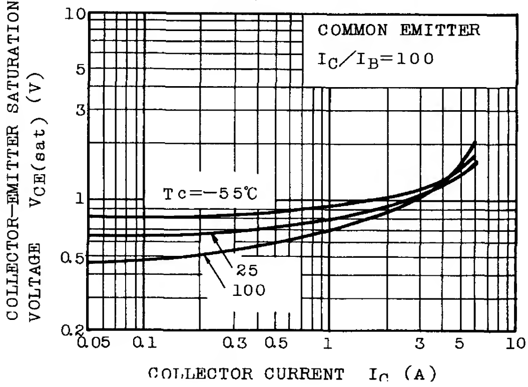
$h_{FE} - I_C$



SAFE OPERATING AREA



$V_{CE(sat)} - I_C$



SILICON NPN TRIPLE DIFFUSED MESA TYPE

2SD1090

COLOR TV POWER REGULATOR APPLICATIONS.

FEATURES:

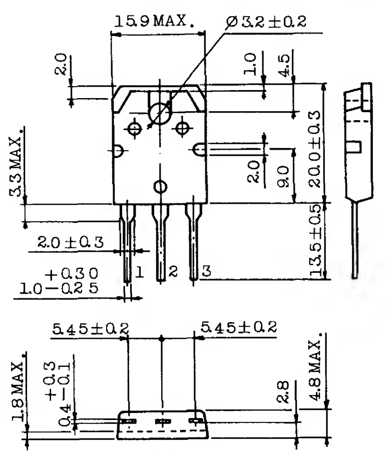
. High Voltage : V_{CEO}=180V

. High DC Current Gain : h_{FE}=500(Min.)

. Large Collector Power Dissipation Capability

: P_C=80W

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−16B1A

Weight : 4.6g

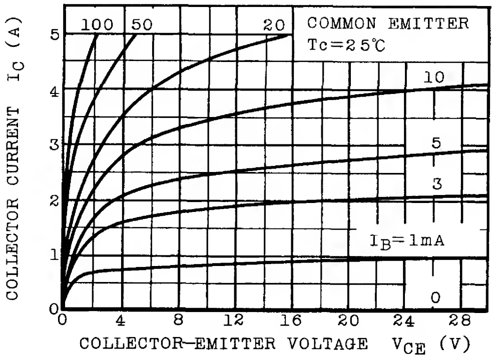
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	V_{CEO}	180	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~150	°C

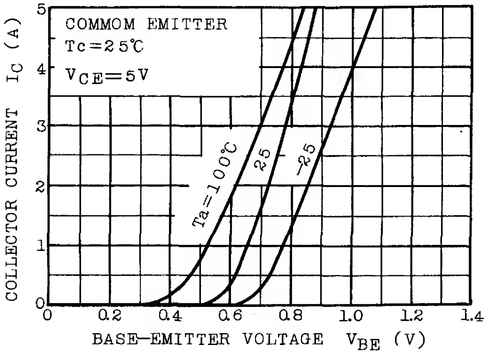
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	100	μA
	I_{CEO}	V_{CE}=180V, I_B=0	-	-	10	mA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	180	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	500	-	2000	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=1A, I_B=20mA	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=1A	0.60	0.70	0.80	V

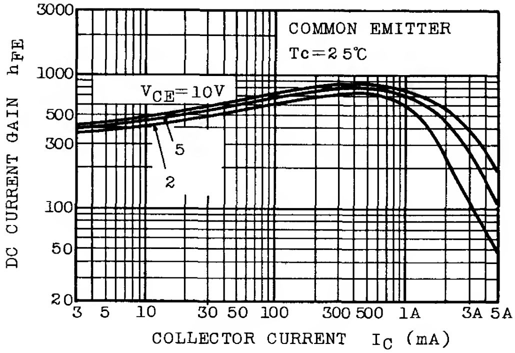
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



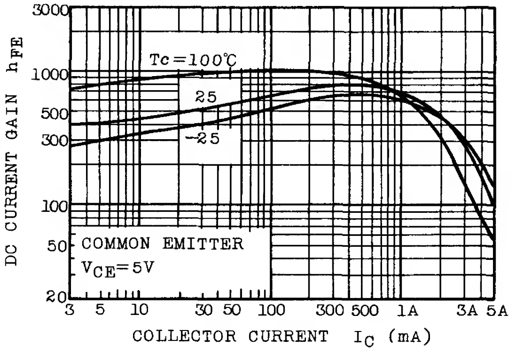
$I_C - V_{BE}$



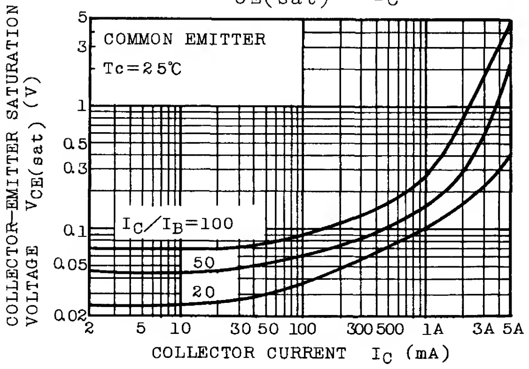
$h_{FE} - I_C$



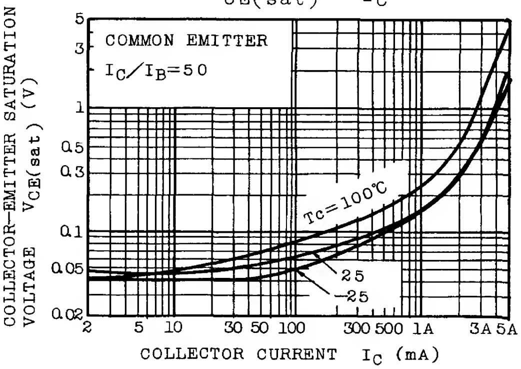
$h_{FE} - I_C$

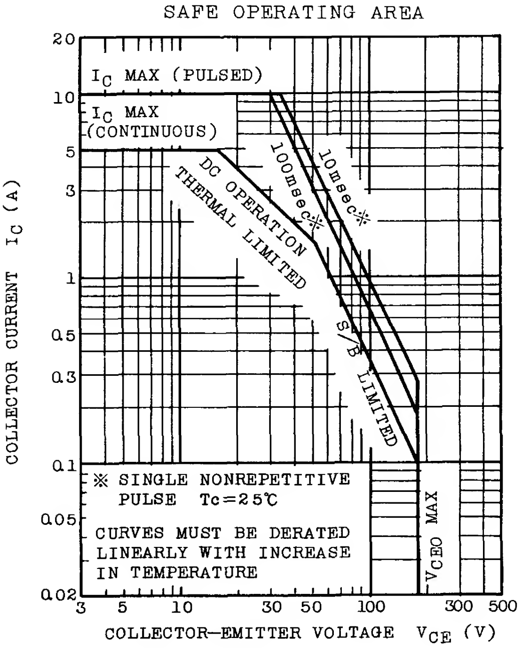


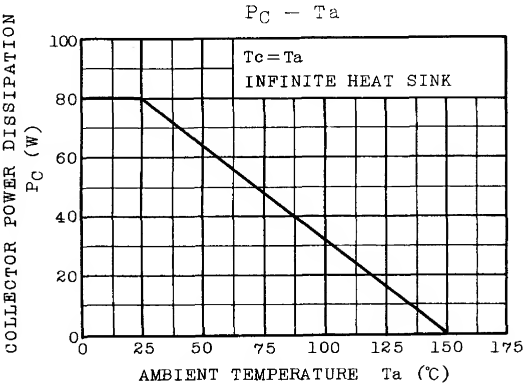
$V_{CE(sat)} - I_C$



$V_{CE(sat)} - I_C$




SAFE OPERATING AREA
IC MAX (PULSED)
IC MAX (CONTINUOUS)
DC OPERATION THERMAL LIMITED
100msec※
10msec※
S/B LIMITED
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.02
3
5
10
30
50
100
300
500
COLLECTOR–EMITTER VOLTAGE VCE (V)

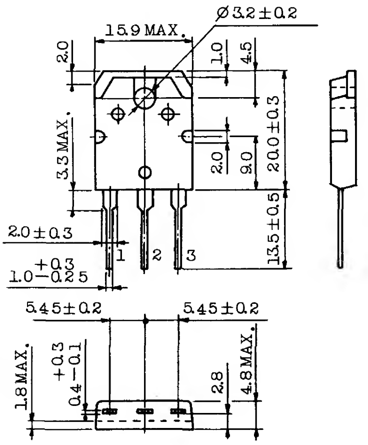

PC – Ta
Tc=Ta
INFINITE HEAT SINK
COLLECTOR POWER DISSIPATION PC (W)
100
80
60
40
20
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)

2SD1092

SILICON NPN DOUBLE DIFFUSED TYPE (PCT PROCESS)

POWER REGULATOR FOR LINE OPERATED TV.

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight: 4.6g

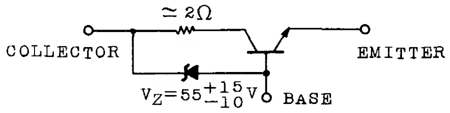
FEATURES:

- Excellent Wide Safe Operating Area (80 W.Sec at Tc=25°C)
- Included Abalanche Diode: $V_Z=55^{+15V}_{-10V}$
- High DC Current Gain : $h_{FE} \geq 500$
- High Collector Power Dissipation Capability : 80W at 25°C Case Temperature

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	55^{+15}_{-10}	V
Collector-Emitter Voltage	V_{CEO}	55^{+15}_{-10}	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current (Continuous)	I_C	4	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

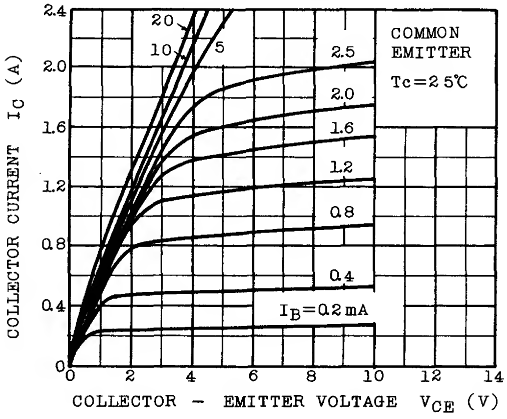
EQUIVALENT CIRCUIT



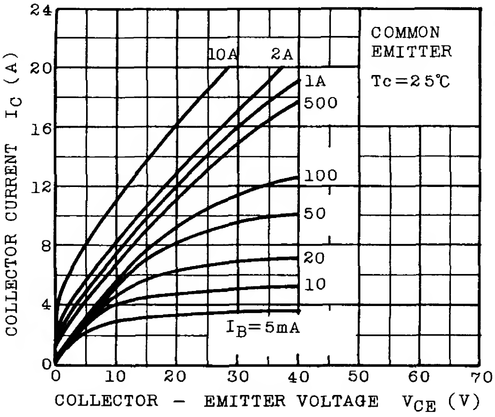
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	45	55	70	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	45	55	70	V
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=500mA	500	1000	2500	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (1)	I_C=500mA, I_B=2mA	-	-	2.0	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (2)	I_C=1.0A, I_B=20mA	-	-	3.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=500mA	0.50	0.65	0.80	V
Allowable Energy (Tc=25°C)	E_T	Application Circuit	80	-	-	W.sec

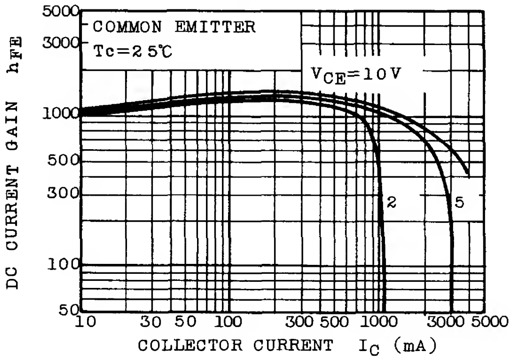
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



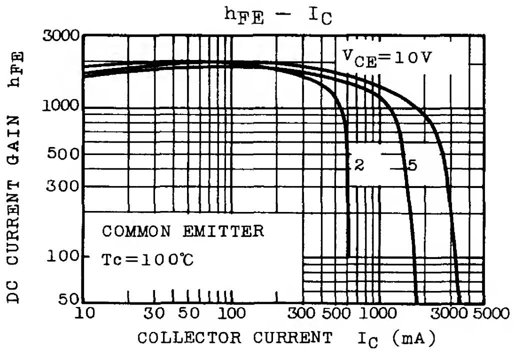
$I_C - V_{CE}$ (HIGH CURRENT REGION)



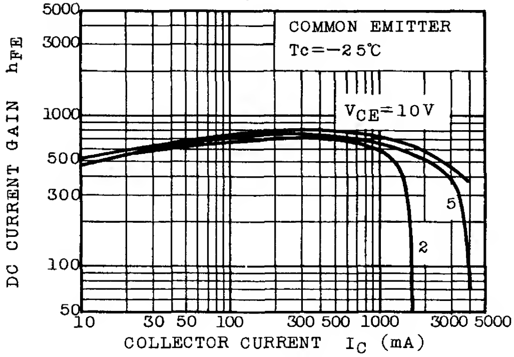
$h_{FE} - I_C$



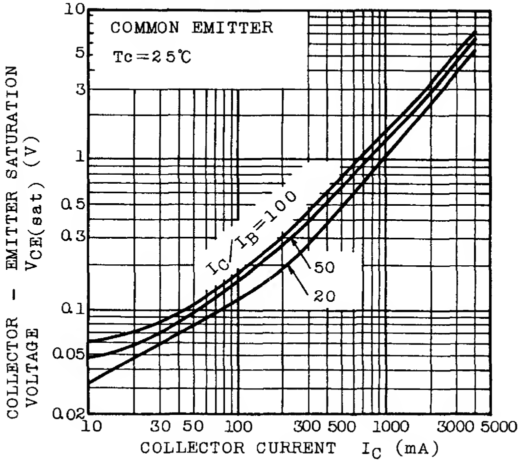
$h_{FE} - I_C$

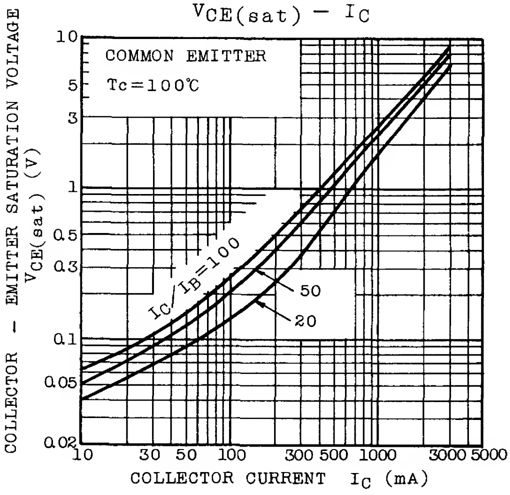


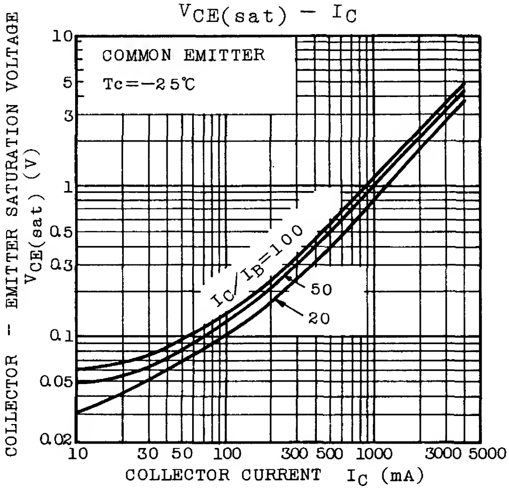
$h_{FE} - I_C$

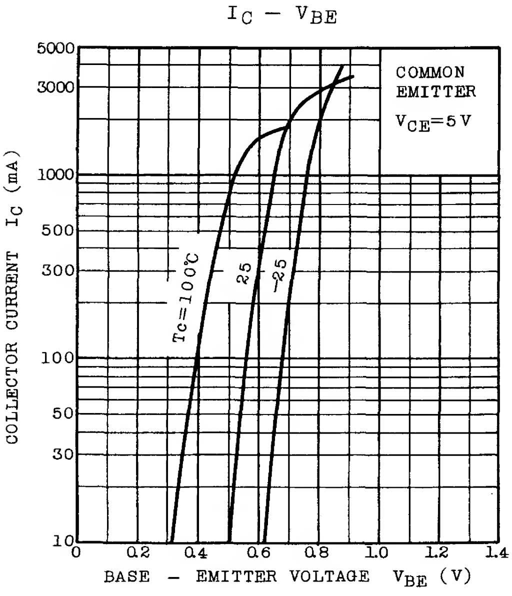


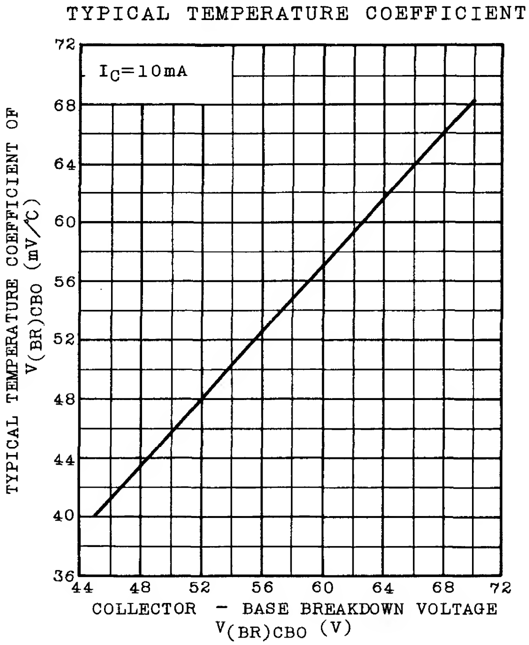
$V_{CE(sat)} - I_C$



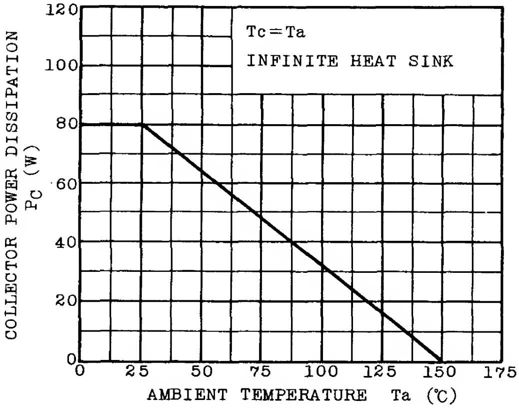

$V_{CE(sat)}$ – I_C
COMMON EMITTER
Tc=100℃
I_C/I_B=100
50
20
COLLECTOR – EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
10
5
3
1
0.5
0.3
0.1
0.05
0.02
10
30
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
Tc=−25℃
I_C/I_B=100
50
20
COLLECTOR – EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
10
5
3
1
0.5
0.3
0.1
0.05
0.02
10
30
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT I_C (mA)

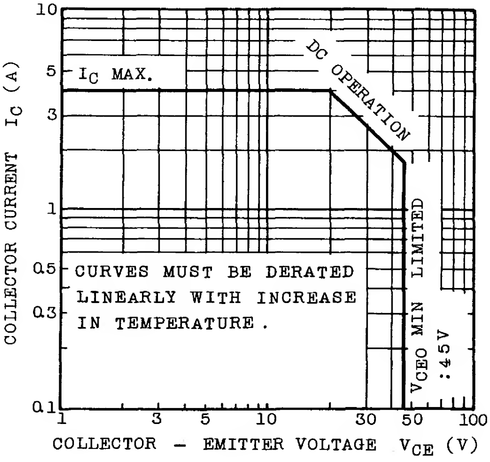

I_C – V_{BE}
COMMON EMITTER
V_{CE}=5 V
Tc=100℃
25
−25
COLLECTOR CURRENT I_C (mA)
5000
3000
1000
500
300
100
50
30
10
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE – EMITTER VOLTAGE V_{BE} (V)


TYPICAL TEMPERATURE COEFFICIENT
I_C=10mA
TYPICAL TEMPERATURE COEFFICIENT OF $V_{(BR)CBO}$ (mV/℃)
72
68
64
60
56
52
48
44
40
36
44
48
52
56
60
64
68
72
COLLECTOR – BASE BREAKDOWN VOLTAGE $V_{(BR)CBO}$ (V)

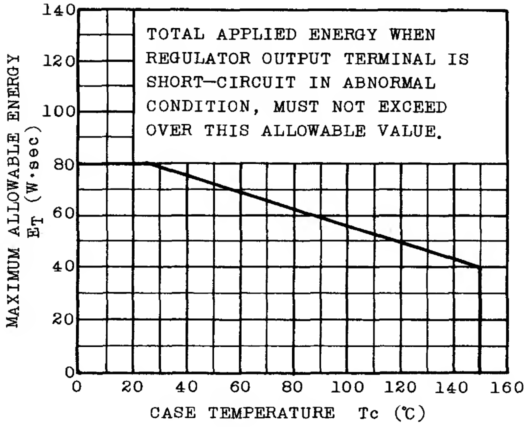
P_C — Ta



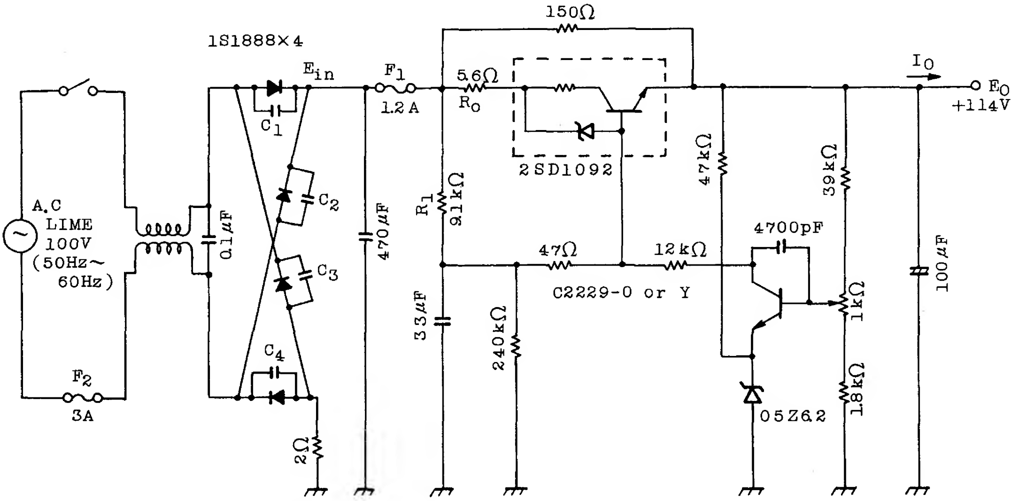
SAFE OPERATING AREA



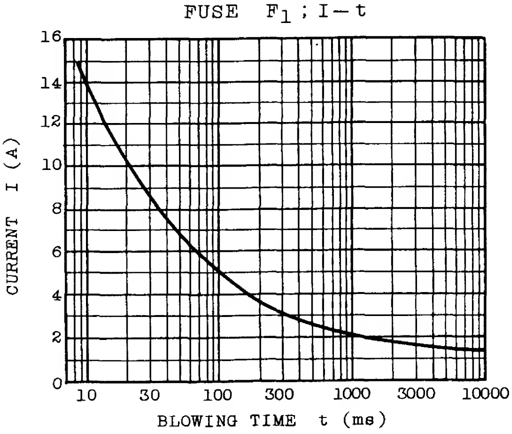
E_T — Tc

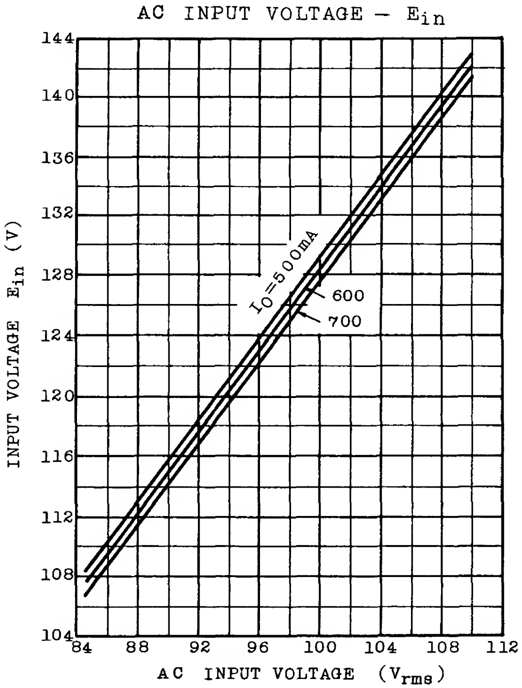


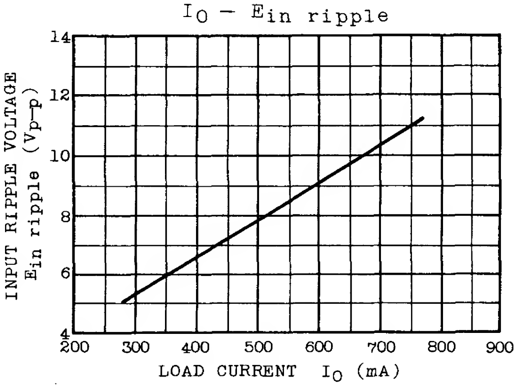
APPLICATION CIRCUIT

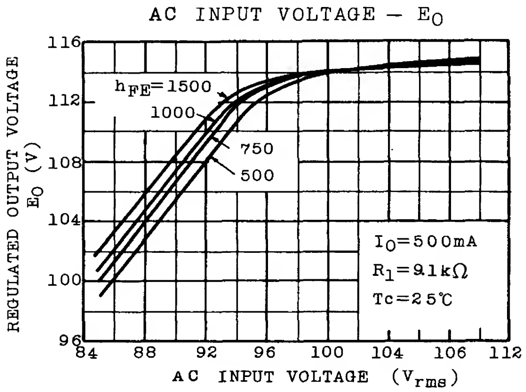


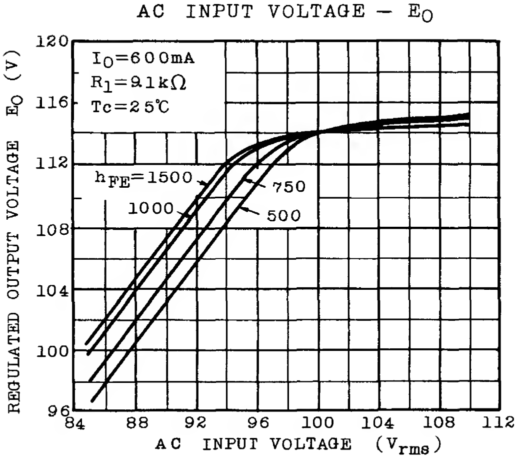
C_1, C_2, C_3, C_4 : 0.0047μF

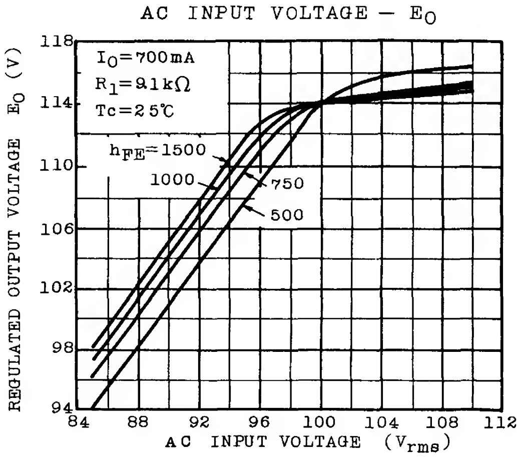



AC INPUT VOLTAGE − E_{in}


I_O − E_{in} ripple


AC INPUT VOLTAGE − E_O


AC INPUT VOLTAGE − E_O

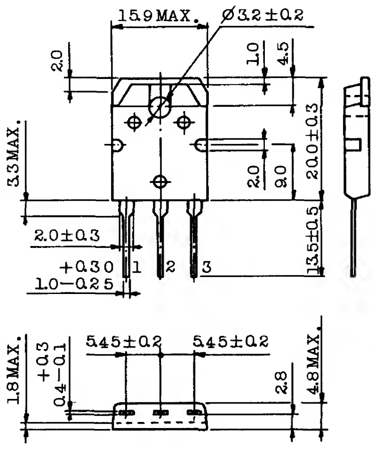

AC INPUT VOLTAGE − E_O

2SD1148

SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

FEATURES:

- Complementary to 2SB863.
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

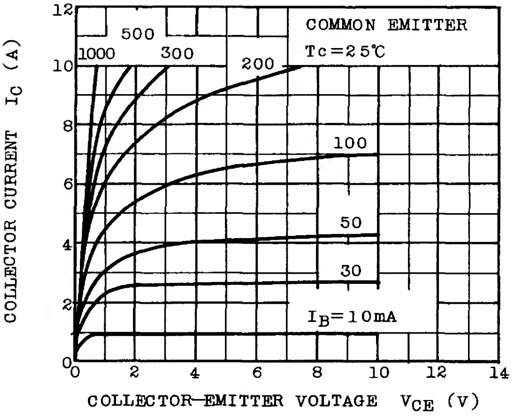
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	140	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°)

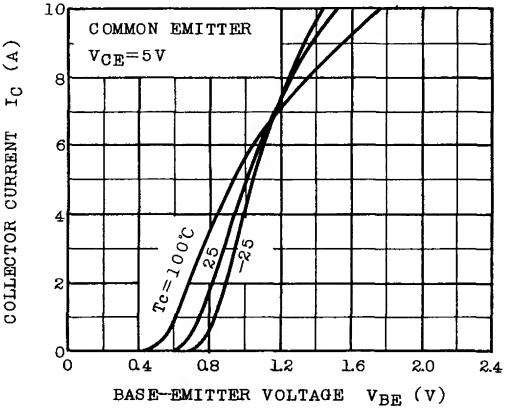
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=140V, I_E=0	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	μA
Collecotr-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	55	-	160	
	$h_{FE(2)}$	V_{CE}=5V, I_C=5A	25	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	0.4	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5A	-	0.96	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=1A	-	20	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	200	-	pF

Note: $h_{FE(1)}$ Classification, R : 55~110 O : 80~160

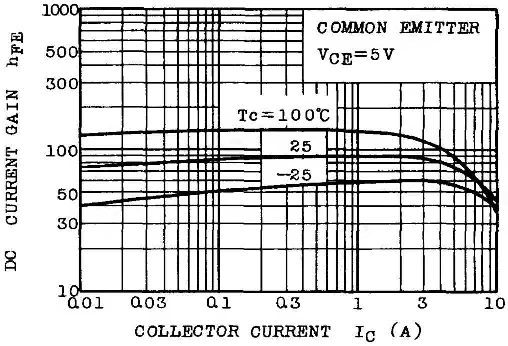
$I_C - V_{CE}$



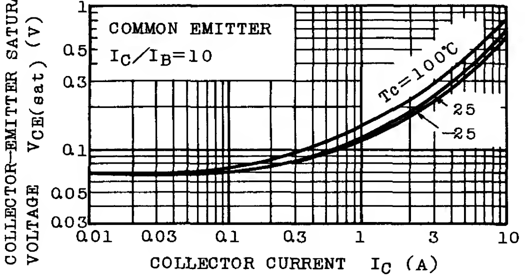
$I_C - V_{BE}$



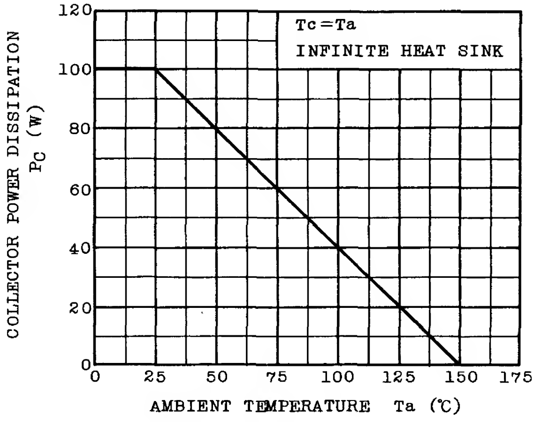
$h_{FE} - I_C$



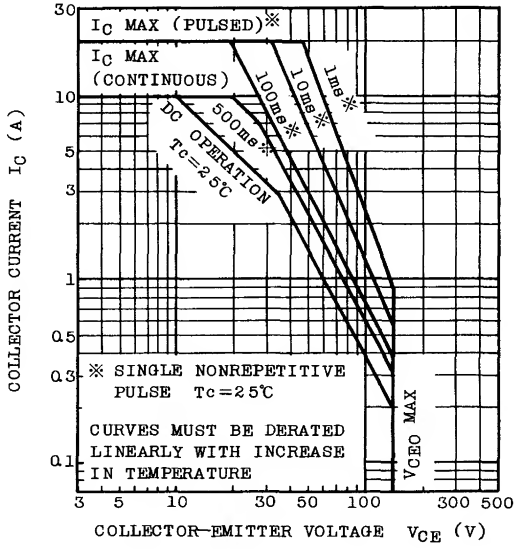
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



2SD1160

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

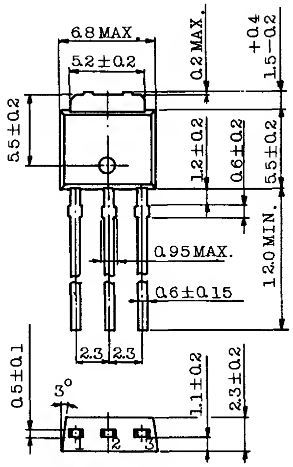
SWITCHING APPLICATIONS.

SUITABLE FOR MOTOR DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain
- Low Saturation Voltage : 0.6V MAX. @I_C=2A, I_B=40mA
- Built-in Free Wheel Diode

Unit in mm



1. BASE
2. COLLECTOR(FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

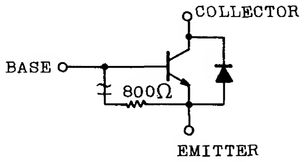
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	20	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	(DC)	I_C	2	A
	(Peak)	I_{CP}	4	A
Diode Forward Surge Current (t=1sec)		I_{FP}	1	A
Collector Power Dissipation		P_C	1	W
Junction Temperature		T_j	150	°C
Storage Temperature		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

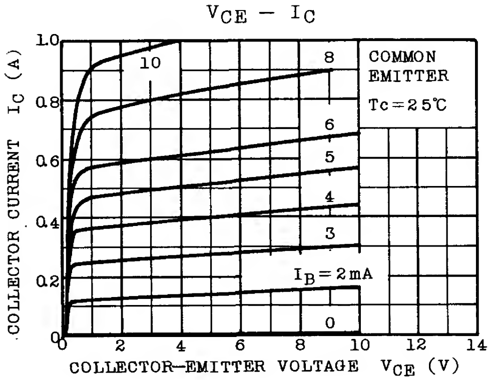
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=50V, I_E=0	-	-	1	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	2.5	6.25	15	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	I_C=20mA, L=40mH	20	-	-	V
DC Current Gain (Note 1)	$h_{FE}(1)$	V_{CE}=2V, I_C=1A	100	-	300	
DC Current Gain	$h_{FE}(2)$	V_{CE}=2V, I_C=2A	60	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=40mA	-	0.4	0.6	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2A, I_B=40mA	-	-	1.5	V
Diode Forward Voltage	$-V_F$	I_F=1A, I_B=0	-	-	2.0	V

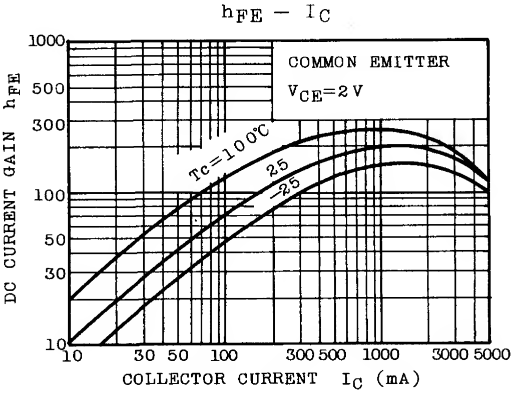
EQUIVALENT CIRCUIT

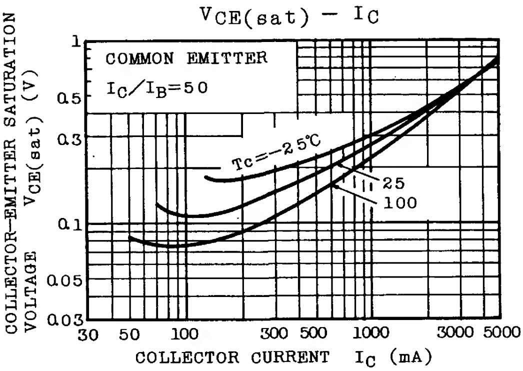


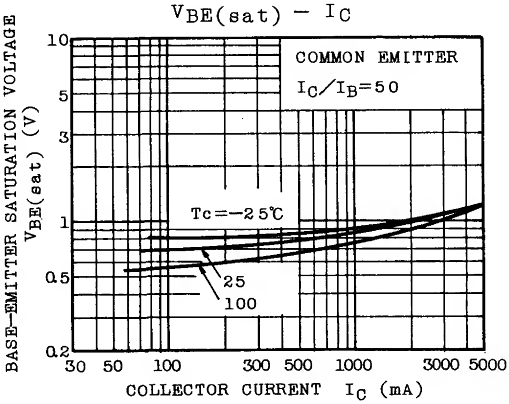
Note 1 : According to the value of $h_{FE}(1)$, 2SD1160 is classified as follows.

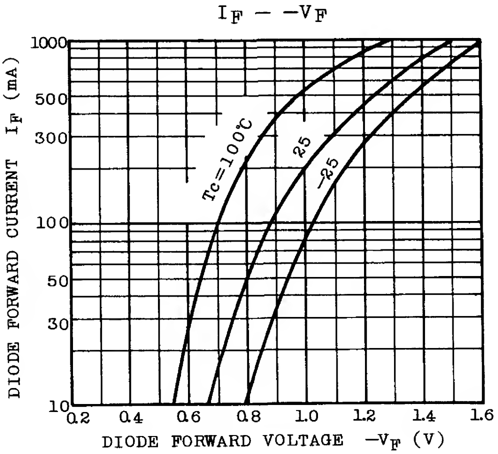
CLASSIFICATION	MIN.	MAX.
2SD1160-O	100	200
2SD1160-Y	150	300

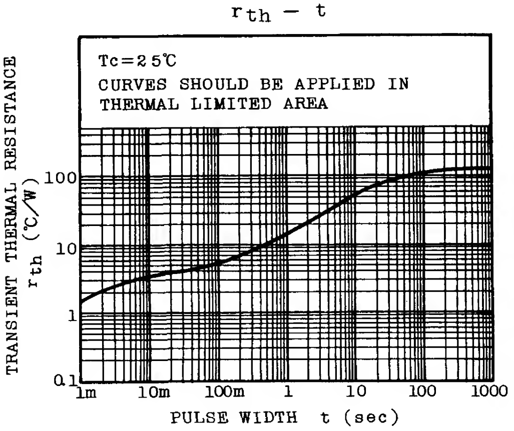

VCE − IC
COMMON EMITTER
Tc=25℃
10
8
6
5
4
3
IB=2mA
0
COLLECTOR CURRENT IC (A)
0, 0.2, 0.4, 0.6, 0.8, 1.0
0, 2, 4, 6, 8, 10, 12, 14
COLLECTOR-EMITTER VOLTAGE VCE (V)

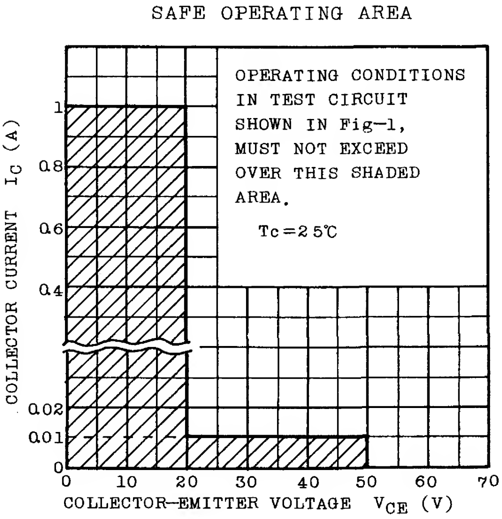

hFE − IC
COMMON EMITTER
VCE=2V
Tc=100℃
25
−25
DC CURRENT GAIN hFE
10, 30, 50, 100, 300, 500, 1000
10, 30, 50, 100, 300, 500, 1000, 3000, 5000
COLLECTOR CURRENT IC (mA)


VCE(sat) − IC
COMMON EMITTER
IC/IB=50
Tc=−25℃
25
100
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
0.03, 0.05, 0.1, 0.3, 0.5, 1
30, 50, 100, 300, 500, 1000, 3000, 5000
COLLECTOR CURRENT IC (mA)

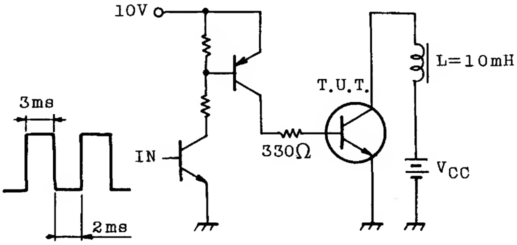

VBE(sat) − IC
COMMON EMITTER
IC/IB=50
Tc=−25℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
0.2, 0.5, 1, 3, 5, 10
30, 50, 100, 300, 500, 1000, 3000, 5000
COLLECTOR CURRENT IC (mA)

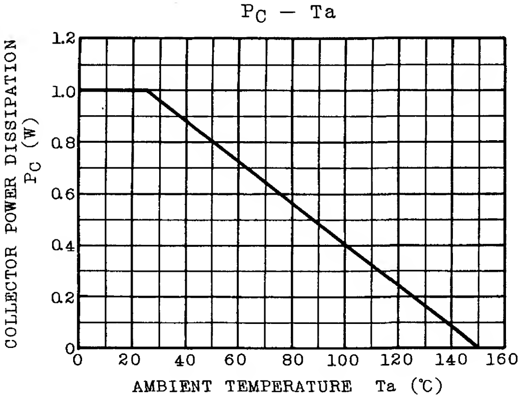

IF − −VF
Tc=100℃
25
−25
DIODE FORWARD CURRENT IF (mA)
10, 30, 50, 100, 300, 500, 1000
0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6
DIODE FORWARD VOLTAGE −VF (V)


rth − t
Tc=25℃
CURVES SHOULD BE APPLIED IN THERMAL LIMITED AREA
TRANSIENT THERMAL RESISTANCE rth (℃/W)
0.1, 1, 10, 100
1m, 10m, 100m, 1, 10, 100, 1000
PULSE WIDTH t (sec)



TEST CIRCUIT





SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

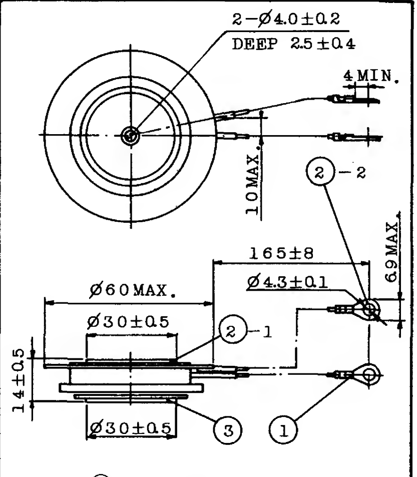
2SD1165A

INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATION.
DC-AC POWER INVERTER APPLICATION.
MOTOR CONTROL APPLICATION.

FEATURES:
- High Voltage : $V_{CEO(SUS)} > 900V$
- Triple Diffused Design
- Darlington Design

Unit in mm



① BASE
②−1 EMITTER
②−2 EMITTER
③ COLLECTOR

JEDEC	―
EIAJ	―
TOSHIBA	2−60B1A

Weight : 150g

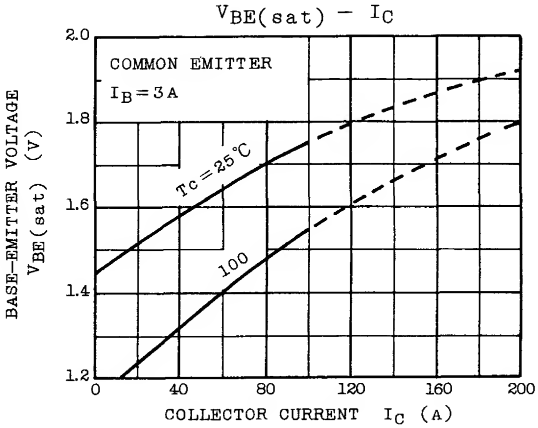
MAXIMUM RATINGS (Ta=25°C)

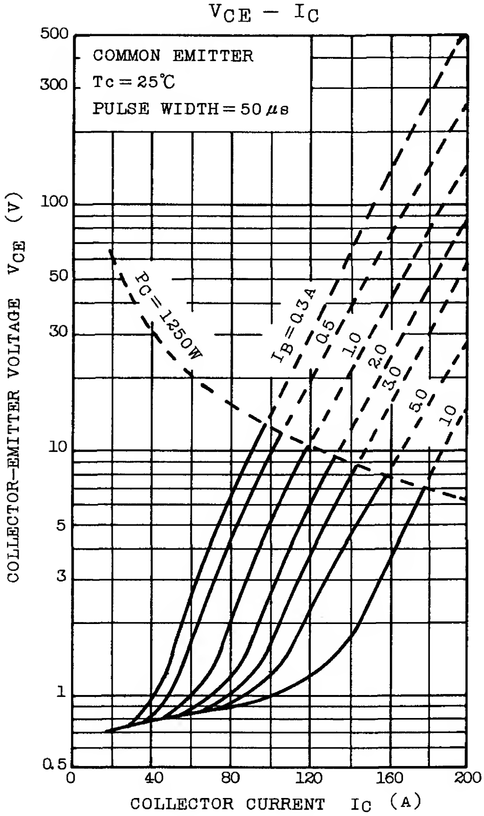
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1000	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	900	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	100	A
Emitter Current	I_E	-100	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.08	°C/W
Junction Temperature	T_j	125	°C
Storage Temperature	T_{stg}	-40~150	°C
Mounting Force Required	F	500±50	kg

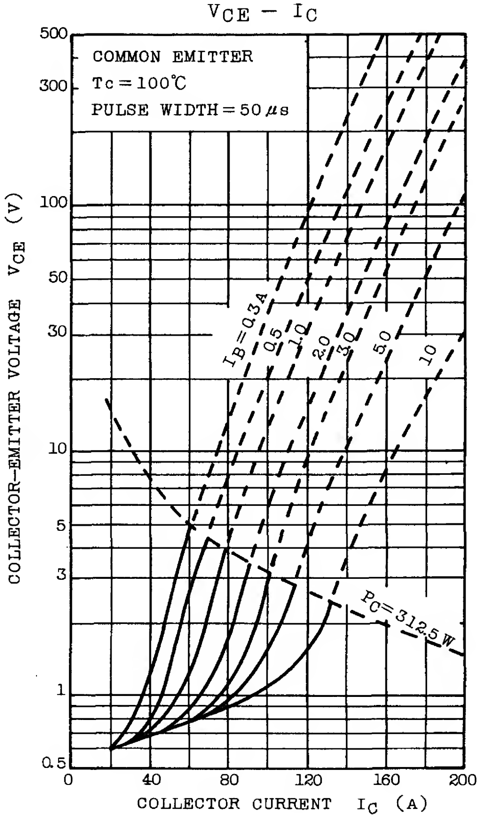
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Forward Current Transfer Ratio		h_{FE}	$V_{CE}=5V,\ I_C=100A$	60	-	-	
			$V_{CE}=5V,\ I_C=50A$	-	500	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A,\ L=40mH$	900	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100A,\ I_B=3A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CBO}	$V_{CB}=1000V,\ I_E=0$	-	-	2	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V,\ I_C=0$	-	-	1000	mA
Switching Time	Turn-on Time	t_{on}	$I_C=100A,\ I_{B1}=3A,$ $-I_{B2}=6A,\ V_C=600V,$ $R_L=6\Omega$	-	1.0	2.0	μs
	Storage Time	t_{stg}		-	20	25	μs
	Fall Time	t_f		-	3.0	5.0	μs

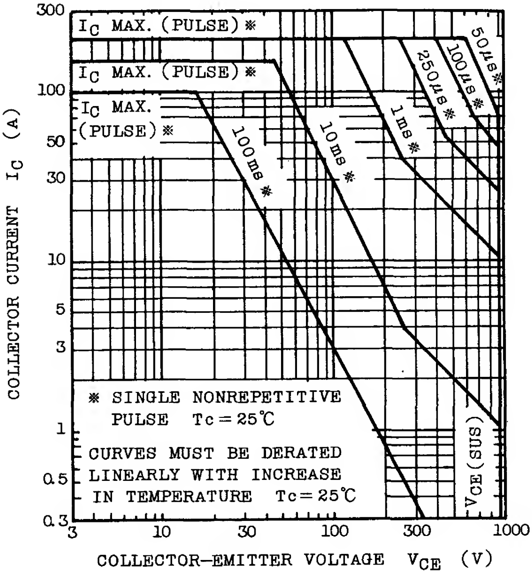
Note : Pulse Test: Pulse Width ≦300μs Duty Cycle ≦3%
Mounting Force; F=500kg


VBE(sat) – IC
COMMON EMITTER
IB=3A
Tc=25°C
100
BASE-EMITTER VOLTAGE VBE(sat) (V)
2.0
1.8
1.6
1.4
1.2
0
40
80
120
160
200
COLLECTOR CURRENT IC (A)

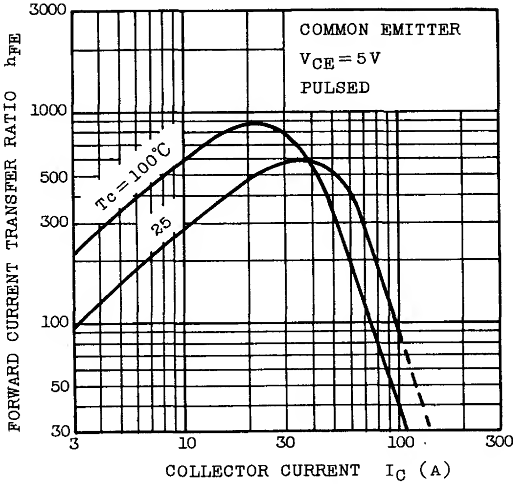

VCE – IC
COMMON EMITTER
Tc=25°C
PULSE WIDTH=50μs
PC=1250W
IB=0.3A
0.5
1.0
2.0
3.0
5.0
10
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
40
80
120
160
200
COLLECTOR CURRENT IC (A)


VCE – IC
COMMON EMITTER
Tc=100°C
PULSE WIDTH=50μs
PC=312.5W
IB=0.3A
0.5
1.0
2.0
3.0
5.0
10
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
40
80
120
160
200
COLLECTOR CURRENT IC (A)

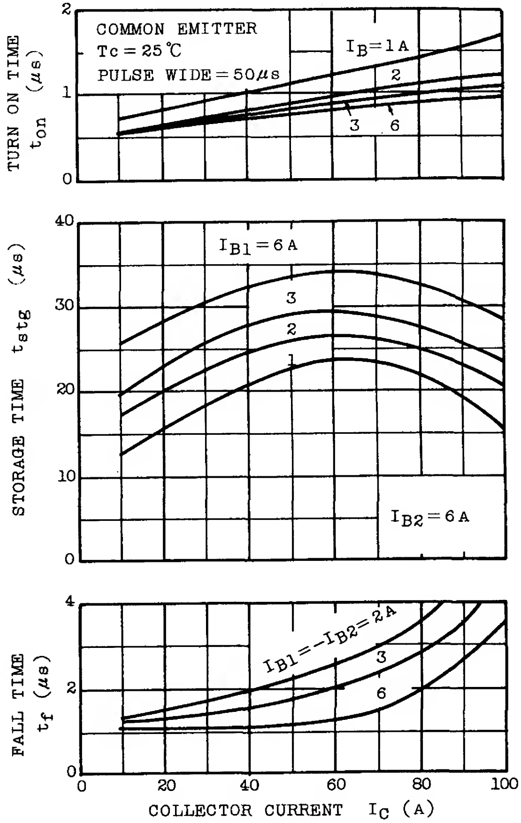
SAFE OPERATING AREA



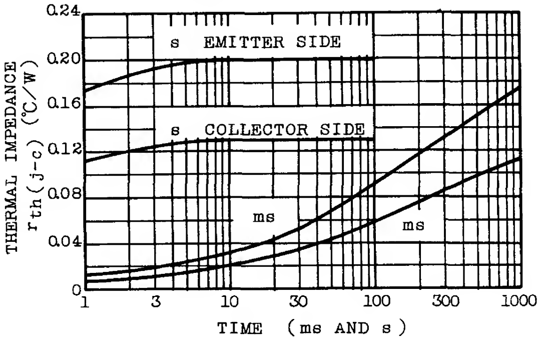
hFE — IC



SWITCHING TIME — IC



TRANSIENT THERMAL IMPEDANCE
(JUNCTION TO CASE)



2SD1166

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

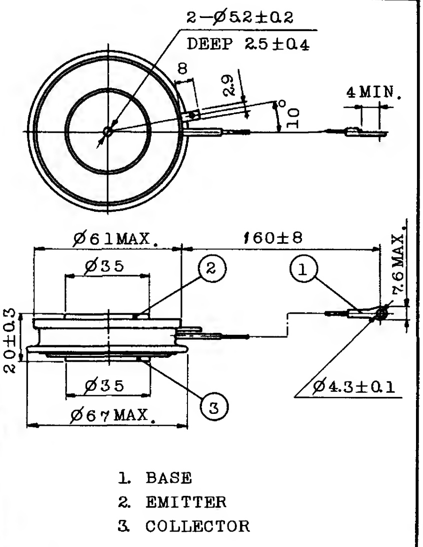
HIGH POWER SWITCHING APPLICATION
AC & DC MOTOR CONTROL APPLICATION
INVERTER APPLICATION

FEATURES:
- High Voltage : $V_{CEO(SUS)} > 900V$
- Triple Diffused Design
- Darlington Design

MAXIMUM RATINGS ($Ta=25^{o}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1000	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	900	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	200	A
Emitter Current	I_E	-200	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	$^{o}C/W$
Junction Temperature	T_j	125	^{o}C
Storage Temperature	T_{stg}	-40 ~ 150	^{o}C
Mounting Force Required	F	1000±100	kg

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2-67B1A

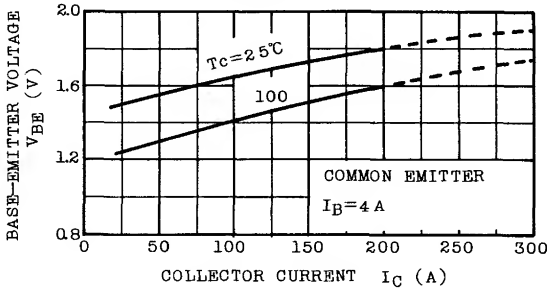
Weight : 250g

ELECTRICAL CHARACTERISTICS ($Ta=25^{o}C$)

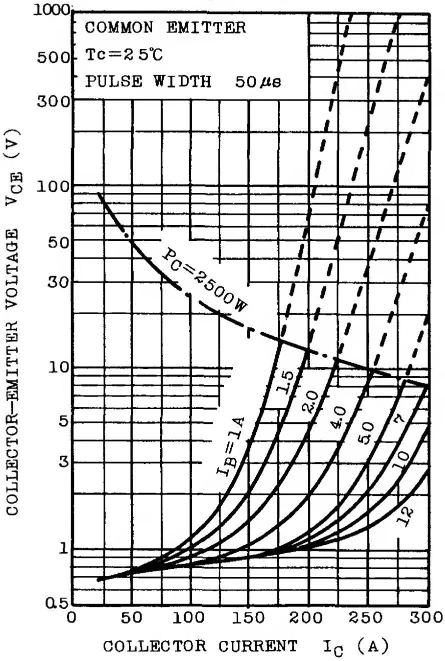
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Forward Current Transfer Ratio		h_{FE}	$V_{CE}=5V$, $I_C=200A$	80	200	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	900	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=200A$, $I_B=5A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CEO}	$V_{CE}=900V$, $I_B=0$	-	1.0	3.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V$, $I_C=0$	-	300	2000	mA
Switching Time	Turn-on Time	t_{on}	$I_C=200A$, $I_{B1}=4A$, $-I_{B2}=8A$, $V_C=600V$	-	1.8	3.0	μs
	Storage Time	t_{stg}		-	24	30	μs
	Fall Time	t_f		-	4.0	8.0	μs

Note: Pulse Test; Pulse Width ≦ 300μs Duty Cycle ≦ 3%
Mounting Foce; F=1000kg

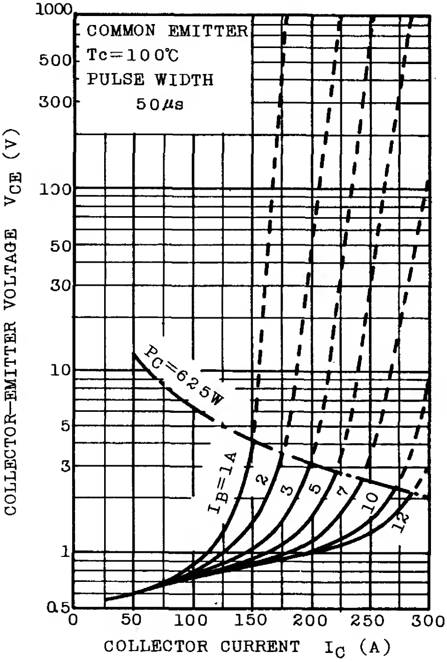
$V_{BE(sat)} - I_C$



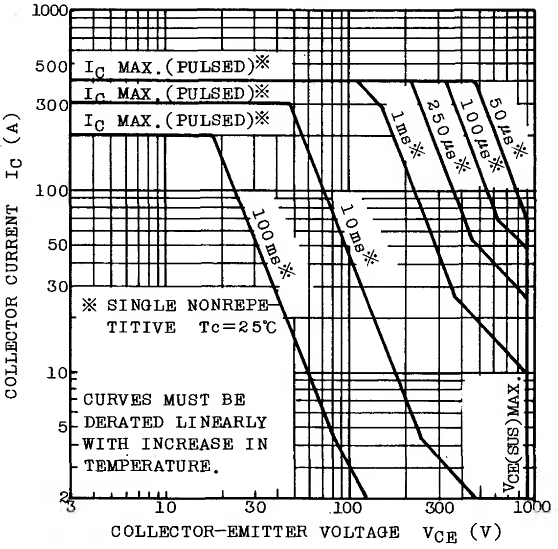
$V_{CE} - I_C$



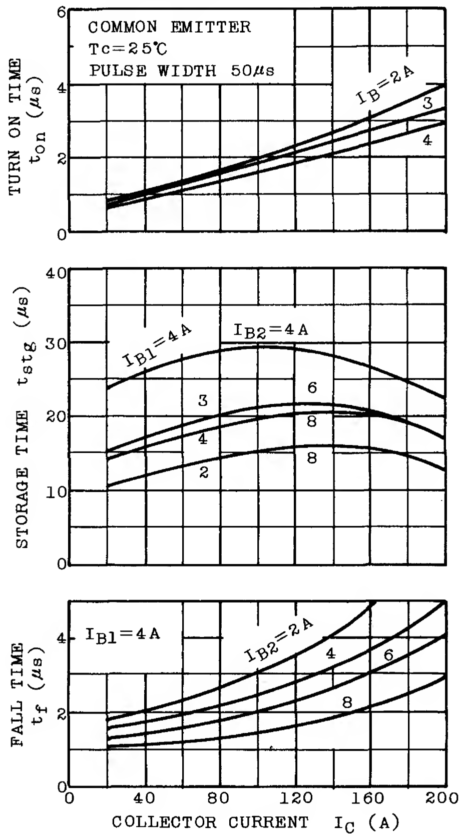
$V_{CE} - I_C$



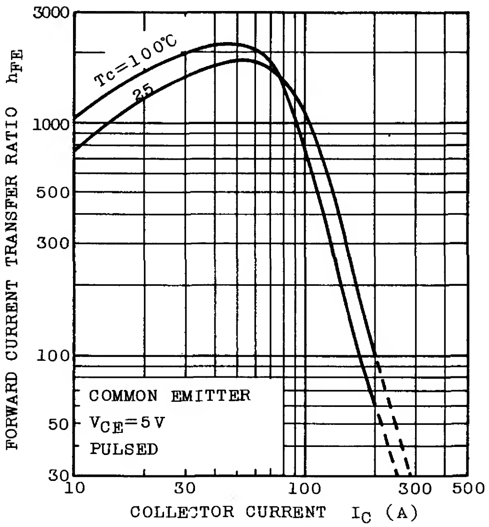
SAFE OPERATING AREA



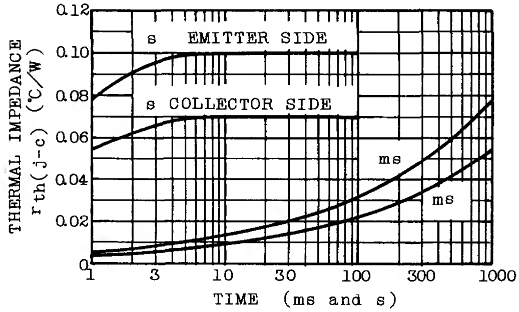
SWITCHING TIME − I_C



h_{FE} − I_C



TRANSIENT THERMAL IMPEDANCE
(JUNCTION TO CASE)



SILICON NPN TRIPLE DIFFUSED TYPE

2SD1187

INDUSTRIAL APPLICATIONS

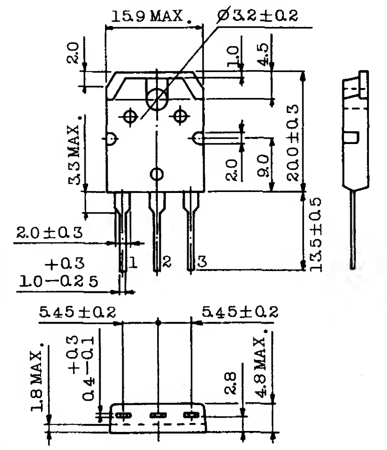
Unit in mm

HIGH POWER SWITCHING APPLICATIONS
DC-DC CONVERTER AND DC-AC INVERTER APPLICATIONS

FEATURES:

. Low Collector-Emitter Saturation Voltage
: $V_{CE(sat)}=0.5V$ (Max.) ($I_C=6A$)

. High Collector Power Dissipation: $P_C=80W$ ($Tc=25^{\circ}C$)



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

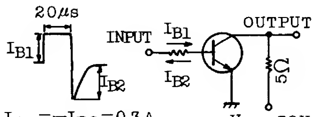
JEDEC	—
EIAJ	—
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation ($Tc=25^{\circ}C$)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

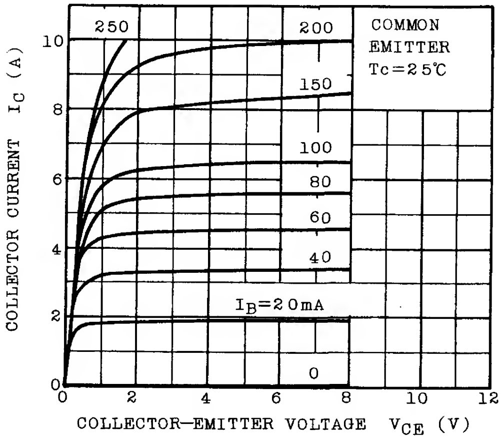
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current		I_{CBO}	$V_{CB}=100V$, $I_E=0$	-	-	10	µA
Emitter Cutoff Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	10	µA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V$, $I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V$, $I_C=6A$	30	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=6A$, $I_B=0.3A$	-	0.3	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=6A$, $I_B=0.3A$	-	0.9	1.4	V
Transition Frequency		f_T	$V_{CE}=4V$, $I_C=1A$	-	10	-	MHz
Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	350	-	pF
Switching Time	Turn-on Time	t_{on}	 20µs I_{B1} I_{B2} INPUT I_{B1} I_{B2} OUTPUT 5Ω $I_{B1}=-I_{B2}=0.3A$ $V_{CC}=30V$ DUTY CYCLE≤1%	-	0.5	-	µs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.8	-	

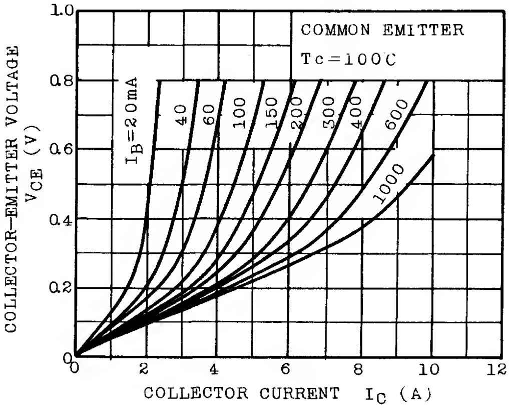
Note: $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

2SD1187

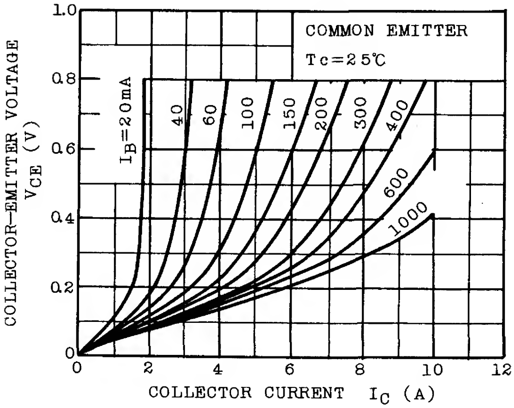
I_C − V_{CE}



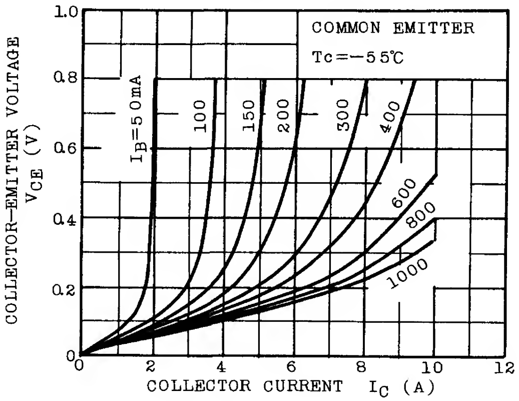
V_{CE} − I_C



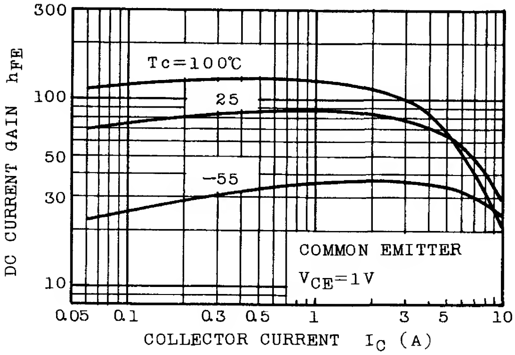
V_{CE} − I_C



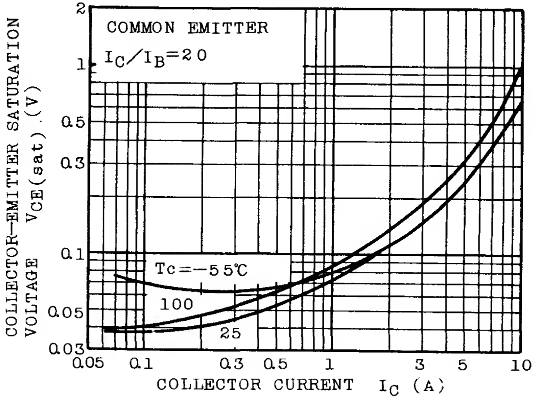
V_{CE} − I_C



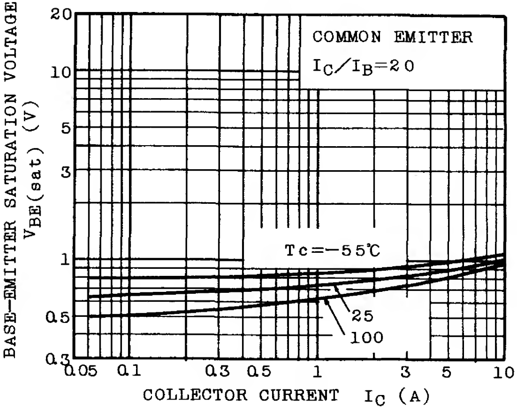
h_{FE} − I_C



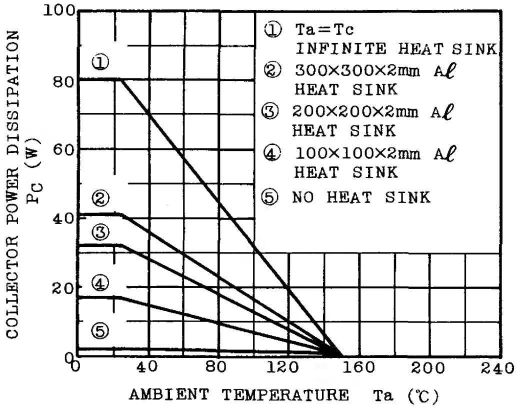
$V_{CE(sat)}$ − I_C



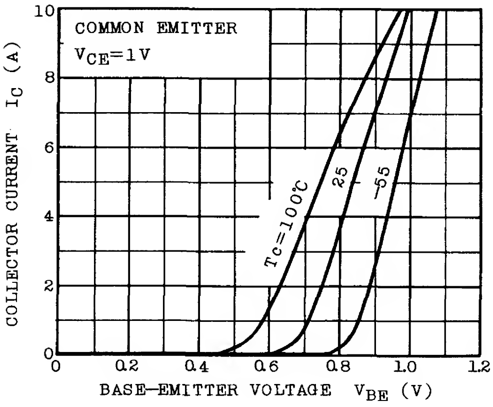
$V_{BE(sat)}$ — I_C



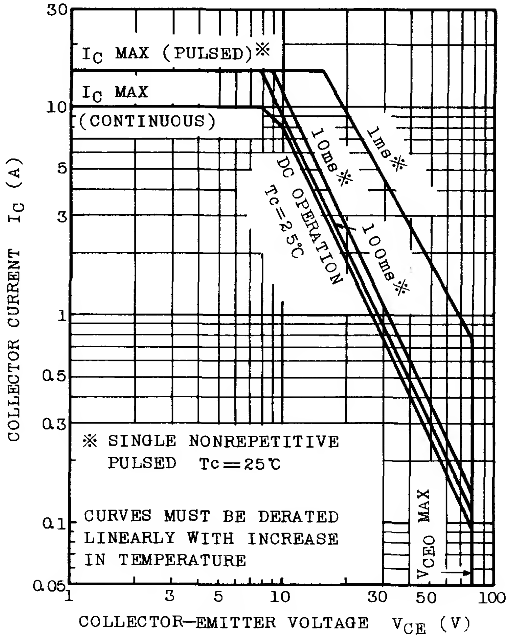
P_C — Ta



I_C — V_{BE}



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSED Tc=25℃

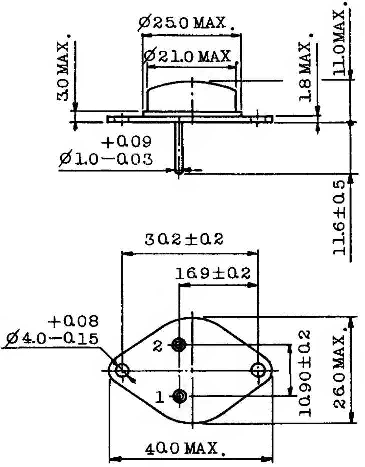
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

2SD1208

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER REGULATOR FOR LINE OPERATED TV.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3 , TB−3
TOSHIBA	2−21A1A

Weight : 12.0g

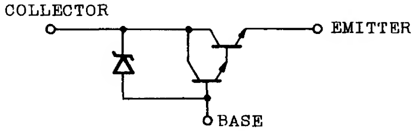
FEATURES:

- Excellent Wide Safe Operating Area (100W.Sec at Tc=25°C)
- Included Abalanche Diode : V_Z=60±15V
- High DC Current Gain : h_{FE}=2000 ~ 20000
- Darlington Connected Type.

MAXIMUM RATINGS (Ta=25°C)

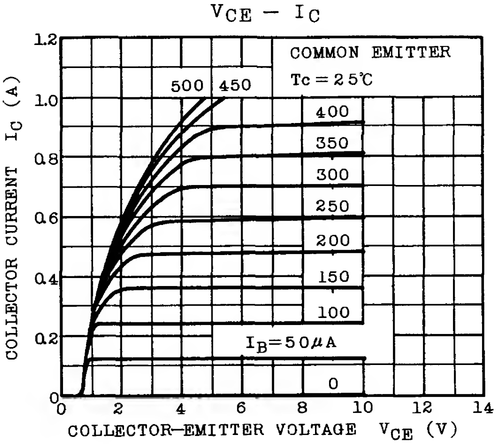
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60±15	V
Collector-Emitter Voltage	V_{CEO}	60±15	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current (Continous)	I_C	5	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation (Tc=25°C)	P_C	100	W
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	-65 ~ 150	°C

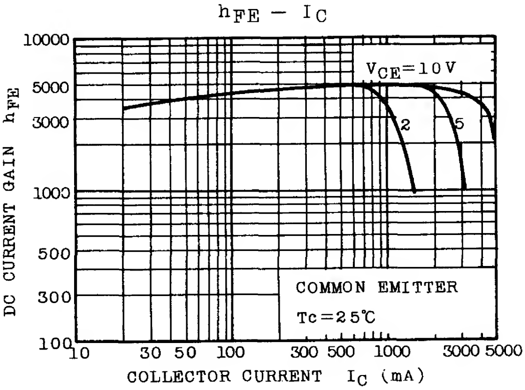
EQUIVALENT CIRCUIT

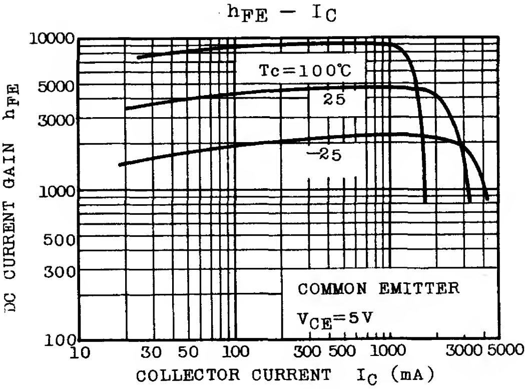


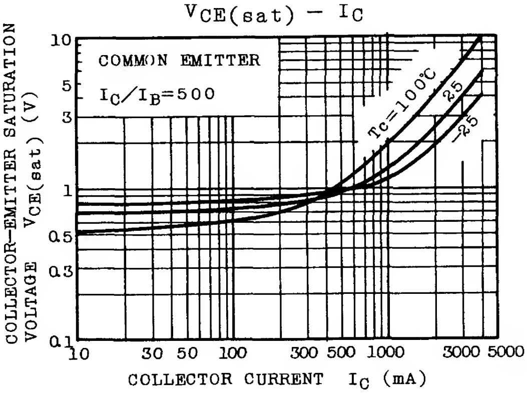
ELECTRICAL CHARACTERISTICS (Ta=25°C)

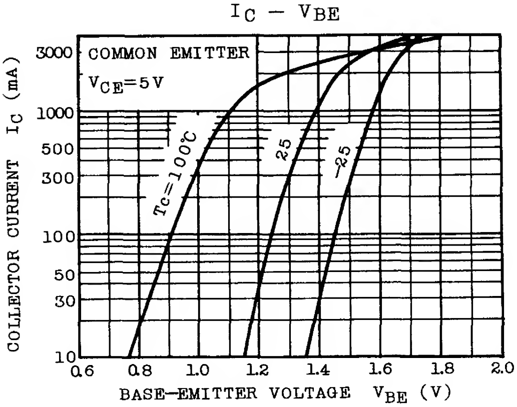
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=10mA, I_E=0	45	60	75	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=100mA, I_B=0	45	60	75	V
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	-	-	100	μA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	2000	-	20000	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (1)	I_C=0.5A, I_B=1mA	-	-	1.5	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (2)	I_C=1A, I_B=1mA	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=0.5A	-	-	1.8	V
Allowable Energy (Tc=25°C)	E_T	Application Circuit	100	-	-	W·sec


VCE − IC
COMMON EMITTER
Tc = 25°C
500
450
400
350
300
250
200
150
100
IB=50μA
0
COLLECTOR CURRENT IC (A)
0
0.2
0.4
0.6
0.8
1.0
1.2
0
2
4
6
8
10
12
14
COLLECTOR-EMITTER VOLTAGE VCE (V)

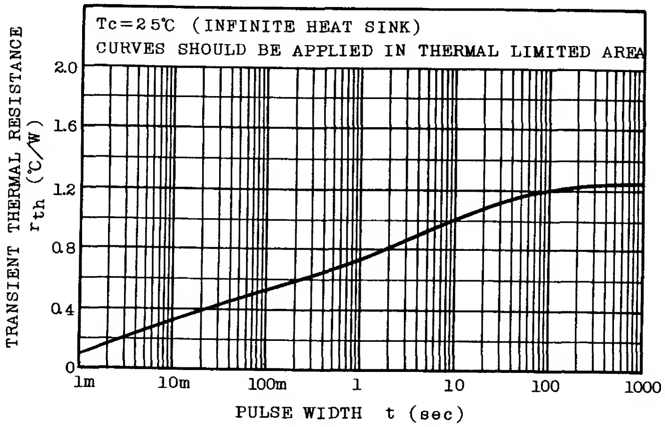

hFE − IC
VCE=10V
2
5
COMMON EMITTER
Tc=25°C
DC CURRENT GAIN hFE
10000
5000
3000
1000
500
300
100
10
30
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT IC (mA)


hFE − IC
Tc=100°C
25
−25
COMMON EMITTER
VCE=5V
DC CURRENT GAIN hFE
10000
5000
3000
1000
500
300
100
10
30
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT IC (mA)

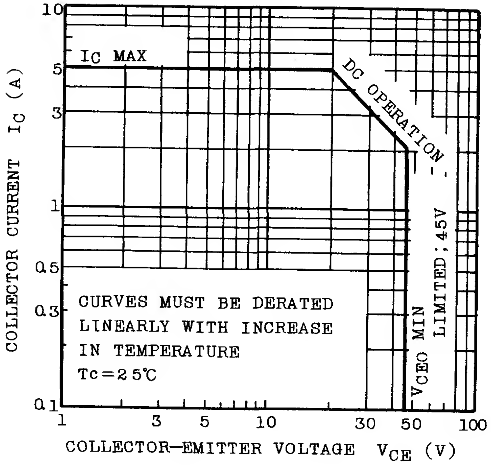

VCE(sat) − IC
COMMON EMITTER
IC/IB=500
Tc=100°C
25
−25
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
10
5
3
1
0.5
0.3
0.1
10
30
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT IC (mA)


IC − VBE
COMMON EMITTER
VCE=5V
Tc=100°C
25
−25
COLLECTOR CURRENT IC (mA)
3000
1000
500
300
100
50
30
10
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
BASE-EMITTER VOLTAGE VBE (V)

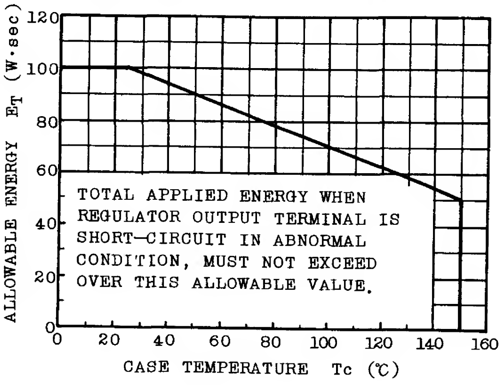
r_{th} – t



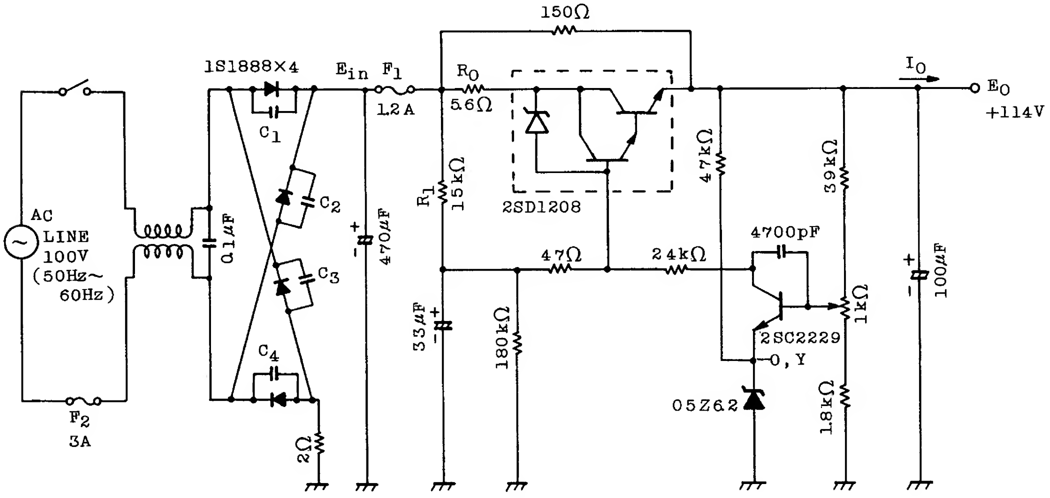
SAFE OPERATING AREA (DC)



E_T (MAXIMUM ALLOWABLE ENERGY) – Tc

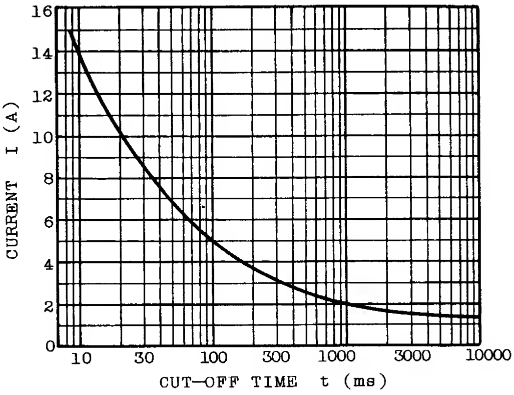


APPLICATION CIRCUIT

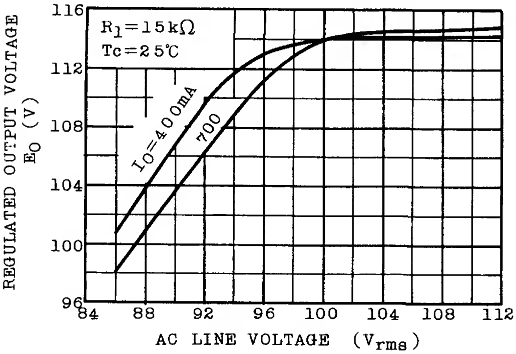


C_1, C_2, C_3, C_4 : 0.0047μF

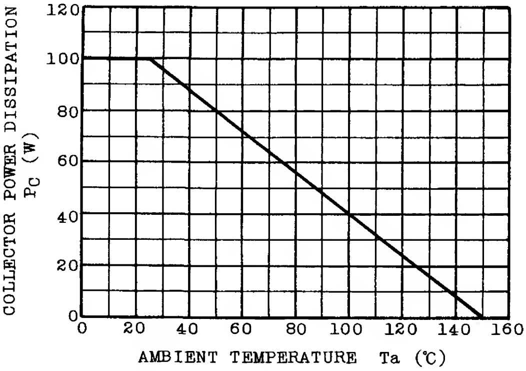
FUSE F_1 ; I−t CHARACTERISTIC



AC LINE VOLTAGE — E_O



P_C — Ta



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

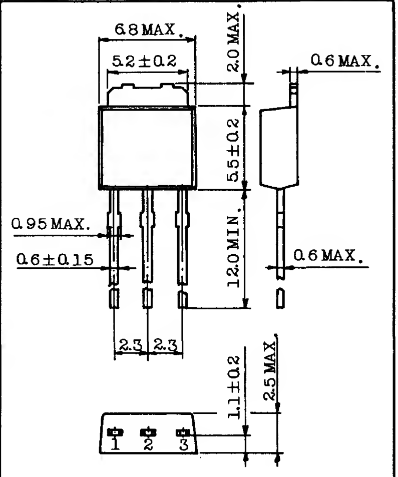
2SD1220

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB905

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−7B1A

Weight : 0.36g

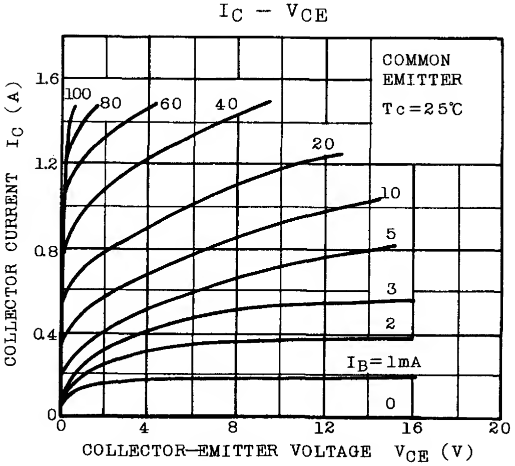
MAXIMUM RATINGS (Ta=25°C)

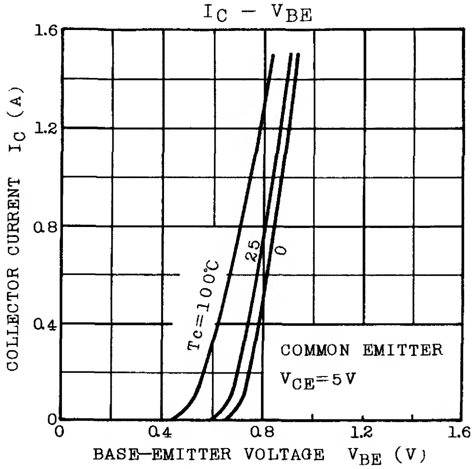
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	150	V
Collector-Emitter Voltage		V_{CEO}	150	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	1.5	A
Base Current		I_B	1.0	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

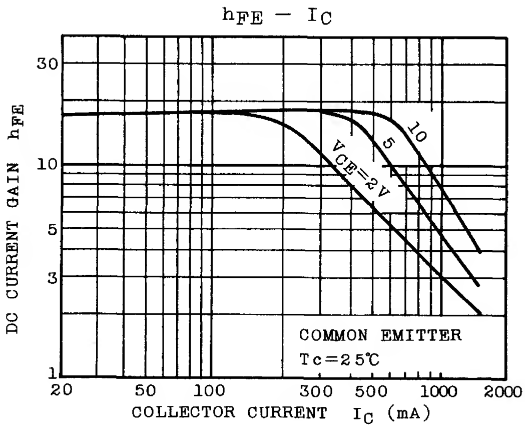
ELECTRICAL CHARACTERISTICS (Ta=25°C)

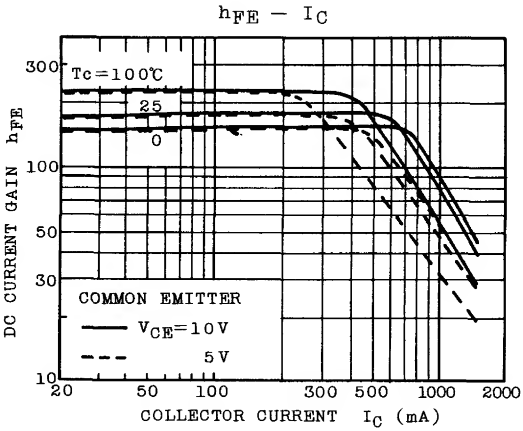
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=150V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	150	-	-	V
DC Current Gain	h_{FE} (Note)	V_{CE}=5V, I_C=200mA	60	-	320	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=5mA	0.5	-	0.8	V
Transition Frequency	f_T	V_{CE}=5V, I_C=200mA	20	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	13	20	pF

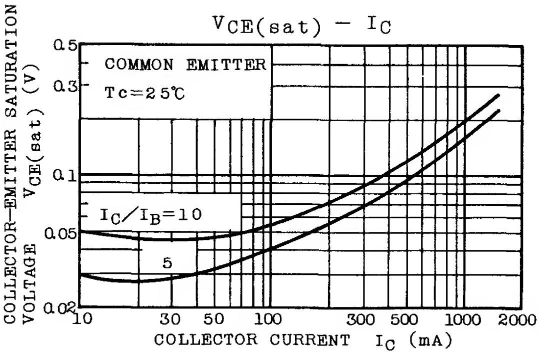
Note: h_{FE} Classification R : 60 ~ 120, O : 100 ~ 200, Y : 160 ~ 320

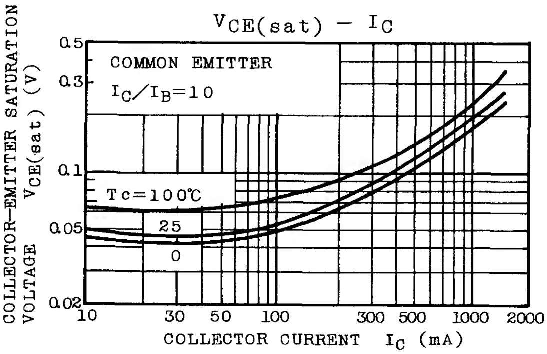

IC − VCE
COMMON EMITTER
Tc=25℃
100
80
60
40
20
10
5
3
2
IB=1mA
0
COLLECTOR CURRENT IC (A)
0
0.4
0.8
1.2
1.6
0
4
8
12
16
20
COLLECTOR−EMITTER VOLTAGE VCE (V)

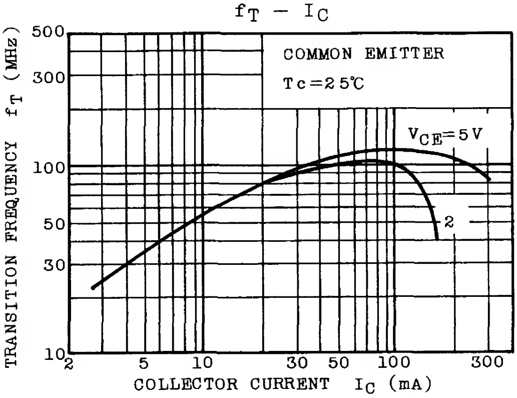

IC − VBE
COMMON EMITTER
VCE=5V
Tc=100℃
25
0
COLLECTOR CURRENT IC (A)
0
0.4
0.8
1.2
1.6
0
0.4
0.8
1.2
1.6
BASE−EMITTER VOLTAGE VBE (V)

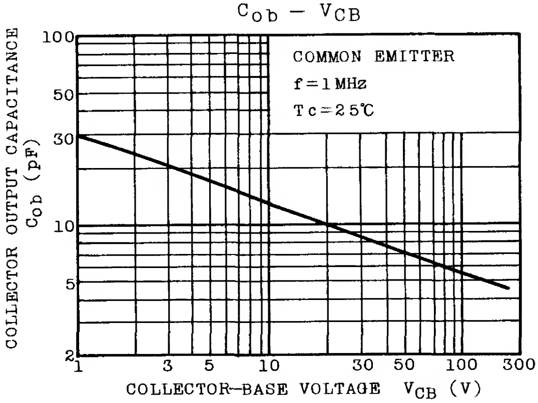

hFE − IC
COMMON EMITTER
Tc=25℃
VCE=2V
5
10
DC CURRENT GAIN hFE
1
3
5
10
30
20
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)

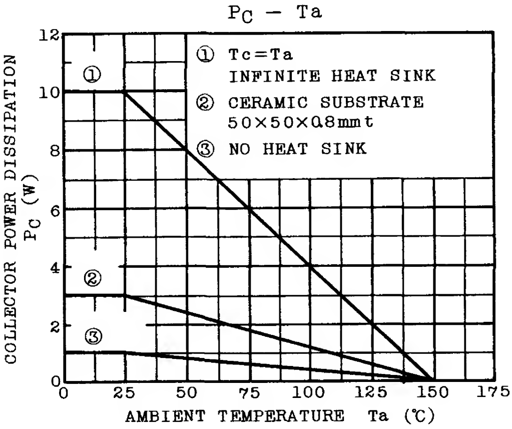

hFE − IC
Tc=100℃
25
0
COMMON EMITTER
VCE=10V
5V
DC CURRENT GAIN hFE
10
30
50
100
300
20
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)

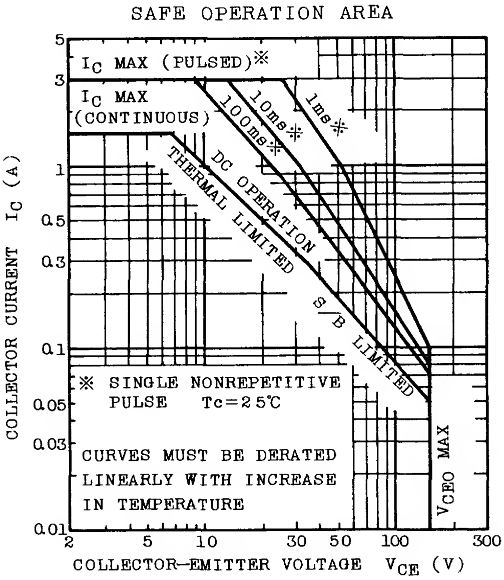

VCE(sat) − IC
COMMON EMITTER
Tc=25℃
IC/IB=10
5
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
0.02
0.05
0.1
0.3
0.5
10
30
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)


VCE(sat) − IC
COMMON EMITTER
IC/IB=10
Tc=100℃
25
0
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
0.02
0.05
0.1
0.3
0.5
10
30
50
100
300
500
1000
2000
COLLECTOR CURRENT IC (mA)


fT − IC
COMMON EMITTER
Tc=25℃
VCE=5V
2
TRANSITION FREQUENCY fT (MHz)
500
300
100
50
30
10
2
5
10
30
50
100
300
COLLECTOR CURRENT IC (mA)


Cob − VCB
COMMON EMITTER
f=1MHz
Tc=25℃
COLLECTOR OUTPUT CAPACITANCE Cob (pF)
100
50
30
10
5
2
1
3
5
10
30
50
100
300
COLLECTOR−BASE VOLTAGE VCB (V)


PC − Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mmt
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
12
10
8
6
4
2
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)

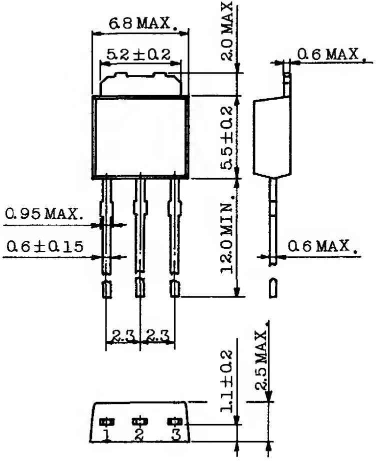

SAFE OPERATION AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
10ms※
1ms※
100ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
2
5
10
30
50
100
300
COLLECTOR−EMITTER VOLTAGE VCE (V)

2SD1221

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-7B1A

Weight : 0.36g

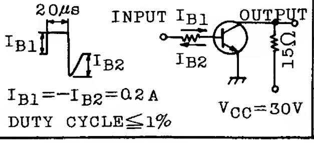
FEATURES:

- Low Collector Saturation Voltage
  : $V_{CE(sat)}=0.4V$(Typ.) ($I_C=3A$, $I_B=0.3A$)
- High Power Dissipation : $P_C=20W$ ($Tc=25^{\circ}C$)
- Complementary to 2SB906

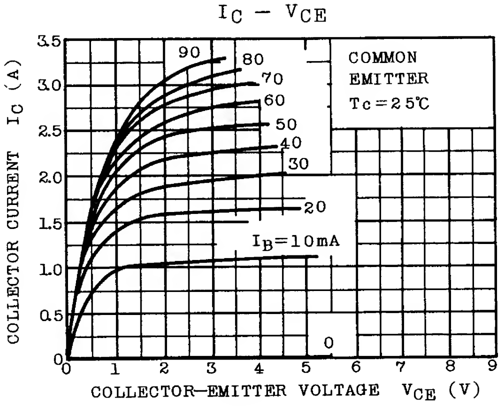
MAXIMUM RATINGS ($Ta=25^{\circ}C$)

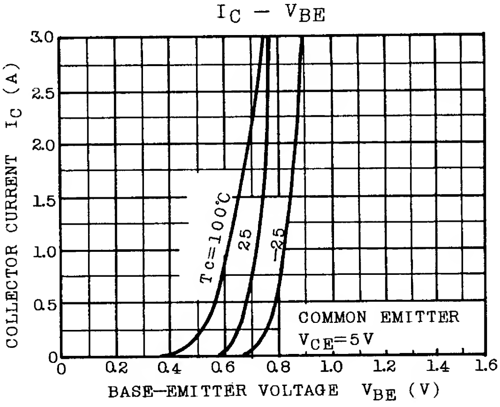
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.0	W
	$Tc=25^{\circ}C$		20	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature		T_{stg}	-55～155	$^{\circ}C$

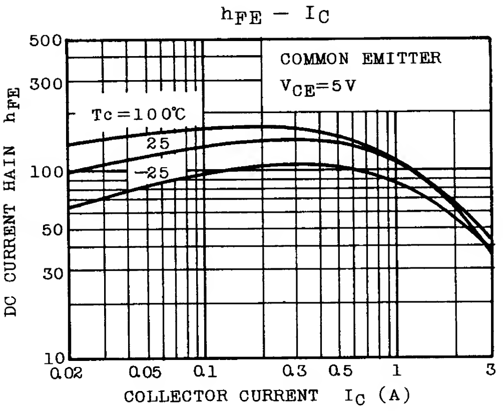
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

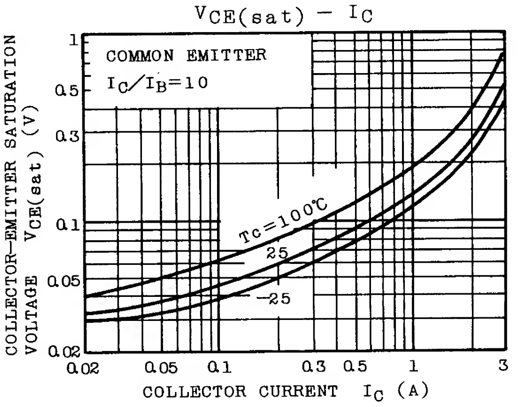
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=60V$, $I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=5V$, $I_C=0.5A$	60	-	300	
		$h_{FE(2)}$	$V_{CE}=5V$, $I_C=3A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A$, $I_B=0.3A$	-	0.4	1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5V$, $I_C=0.5A$	-	0.7	1.0	V
Transition Frequency		f_T	$V_{CE}=5V$, $I_C=0.5A$	-	3.0	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	70	-	pF
Switching Time	Turn-On Time	t_{on}	 20μs INPUT I_{B1} OUTPUT I_{B1} I_{B2} I_{B2} 15Ω $I_{B1}=-I_{B2}=0.2A$ DUTY CYCLE≦1% $V_{CC}=30V$	-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

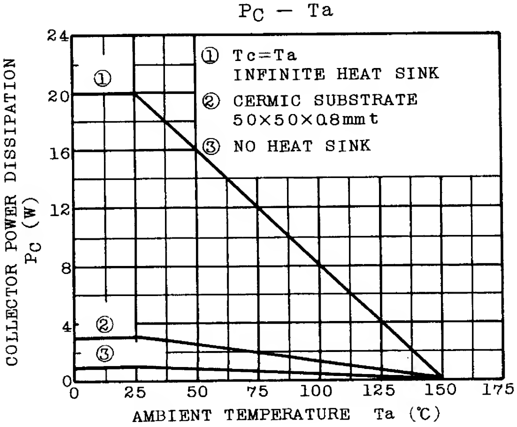
Note: h_{FE} Classification O : 60～120, Y : 100～200, GR : 150～300

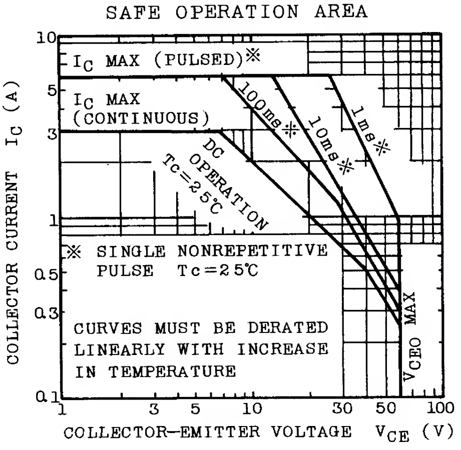

IC − VCE
COMMON EMITTER
Tc=25℃
90
80
70
60
50
40
30
20
IB=10mA
0
COLLECTOR CURRENT IC (A)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0 1 2 3 4 5 6 7 8 9
COLLECTOR−EMITTER VOLTAGE VCE (V)


IC − VBE
Tc=100℃
25
−25
COMMON EMITTER
VCE=5V
COLLECTOR CURRENT IC (A)
3.0
2.5
2.0
1.5
1.0
0.5
0
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6
BASE−EMITTER VOLTAGE VBE (V)


hFE − IC
COMMON EMITTER
VCE=5V
Tc=100℃
25
−25
DC CURRENT HAIN hFE
500
300
100
50
30
10
0.02 0.05 0.1 0.3 0.5 1 3
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC/IB=10
Tc=100℃
25
−25
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
1
0.5
0.3
0.1
0.05
0.02
0.02 0.05 0.1 0.3 0.5 1 3
COLLECTOR CURRENT IC (A)


PC − Ta
① Tc=Ta
INFINITE HEAT SINK
② CERMIC SUBSTRATE
50×50×0.8mmt
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
24
20
16
12
8
4
0
0 25 50 75 100 125 150 175
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATION AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
100ms※
10ms※
1ms※
DC OPERATION Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
1 3 5 10 30 50 100
COLLECTOR−EMITTER VOLTAGE VCE (V)

2SD1222

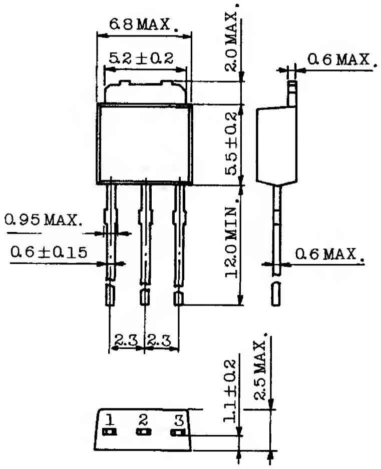
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

. High DC Current Gain
  : $h_{FE(1)}$=2000(Min.) (V_{CE}=2V, I_C=1A)
. Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=2A)
. Complementary to 2SB907.

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

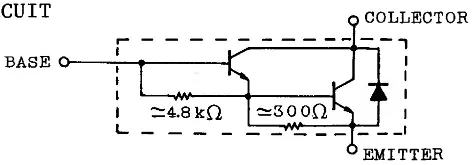
JEDEC	–
EIAJ	–
TOSHIBA	2–7B1A

Weight : 0.36g

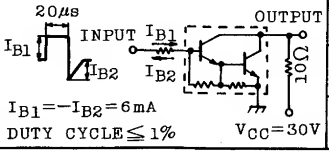
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	40	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	3	A
Base Current		I_B	0.3	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

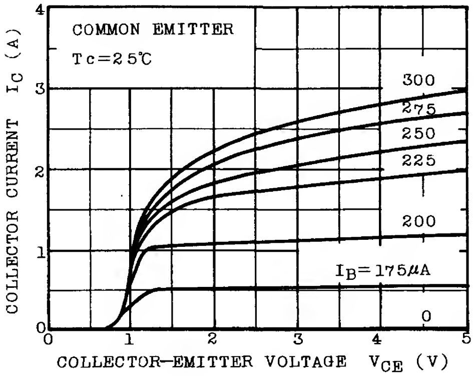
EQUIVALENT CIRCUIT



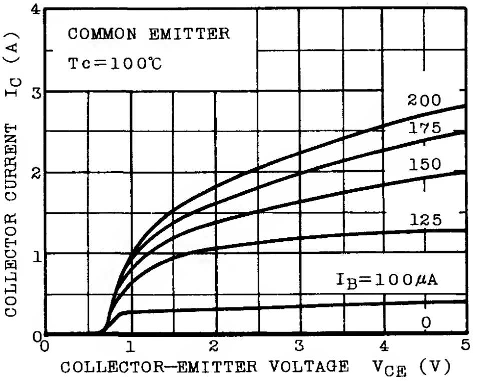
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=25mA, I_B=0	40	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=3A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=2A, I_B=4mA	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=2A, I_B=4mA	-	-	2.0	
Switching Time	Turn-on Time	t_{on}	 I_{B1}=$-I_{B2}$=6mA DUTY CYCLE≦1% V_{CC}=30V	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.2	-	

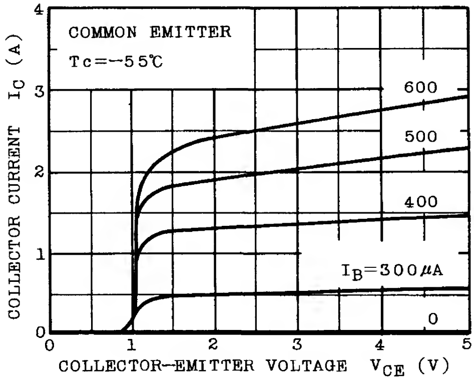
$I_C - V_{CE}$



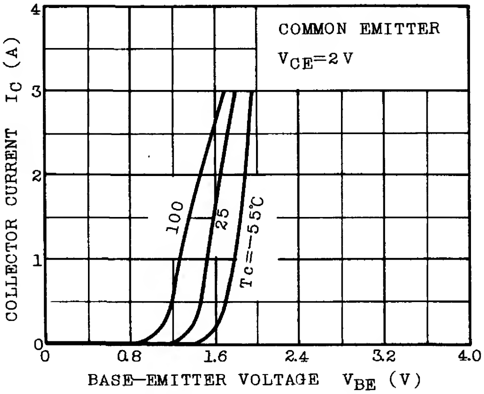
$I_C - V_{CE}$



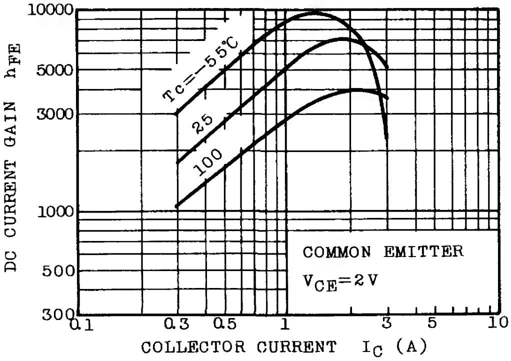
$I_C - V_{CE}$



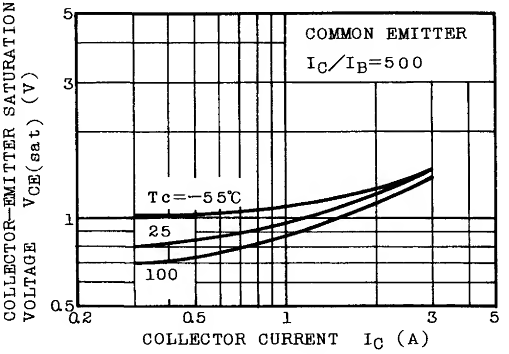
$I_C - V_{BE}$

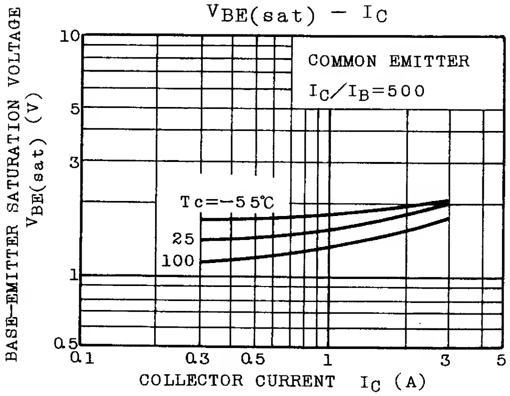


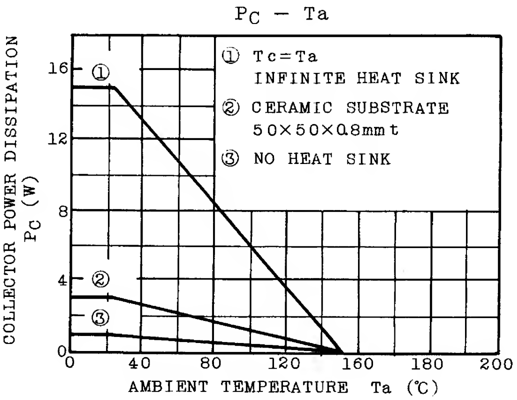
$h_{FE} - I_C$

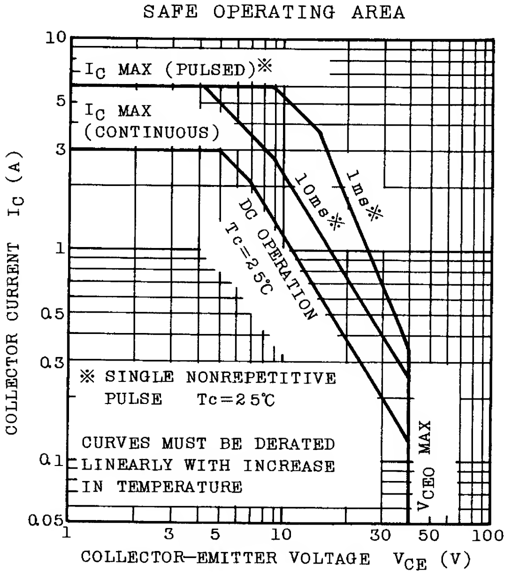


$V_{CE(sat)} - I_C$




VBE(sat) – IC
COMMON EMITTER
IC/IB=500
Tc=−55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
10
5
3
1
0.5
0.1
0.3
0.5
1
3
5
COLLECTOR CURRENT IC (A)


PC – Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mm t
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
16
12
8
4
0
0
40
80
120
160
180
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.3
0.1
0.05
1
3
5
10
30
50
100
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

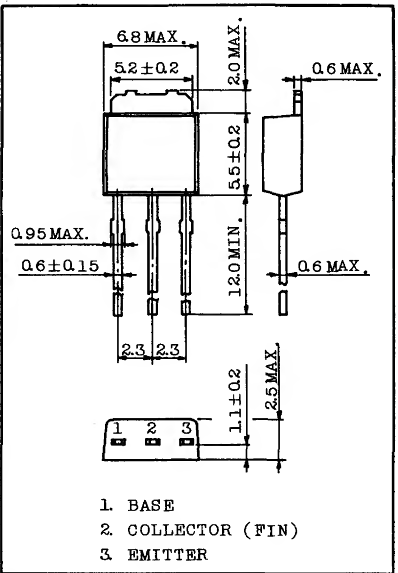
2SD1223

SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : $h_{FE(1)}$=2000(Min.) (V_{CE}=2V, I_C=1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=3A)
- Complementary to 2SB908.

Unit in mm



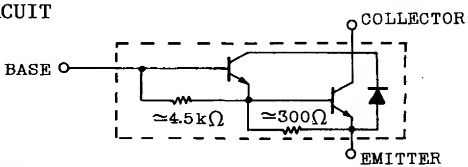
JEDEC	—
EIAJ	—
TOSHIBA	2—7B1A

Weight : 0.36g

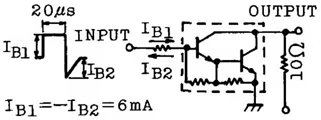
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYBMOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	4	A
Base Current		I_B	0.4	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		15	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

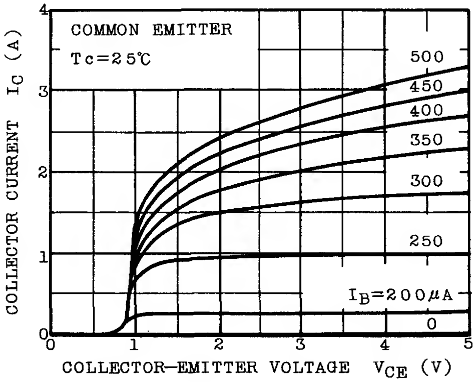
EQUIVALENT CIRCUIT



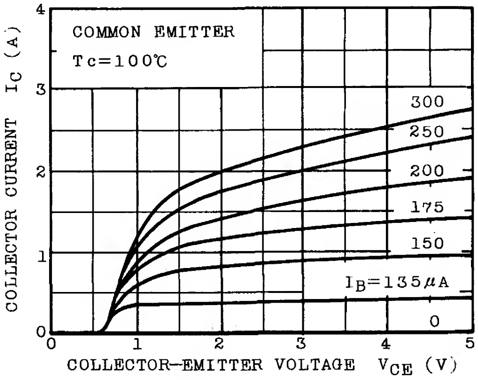
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	-	-	20	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=1A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=3A	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=3A, I_B=6mA	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=3A, I_B=6mA	-	-	2.0	
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT I_{B1} I_{B2} I_{B1} I_{B2} 10Ω I_{B1}=−I_{B2}=6mA DUTY CYCLE≦1% V_{CC}=30V	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.6	-	

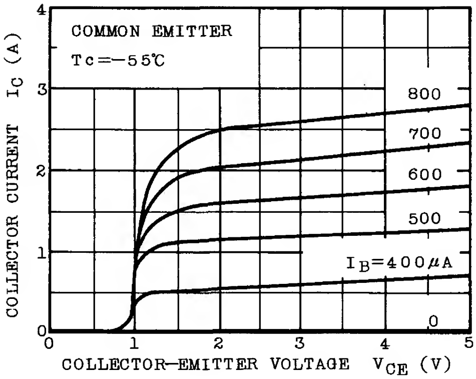
$I_C - V_{CE}$



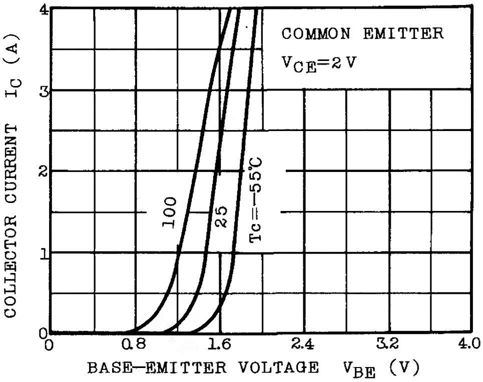
$I_C - V_{CE}$



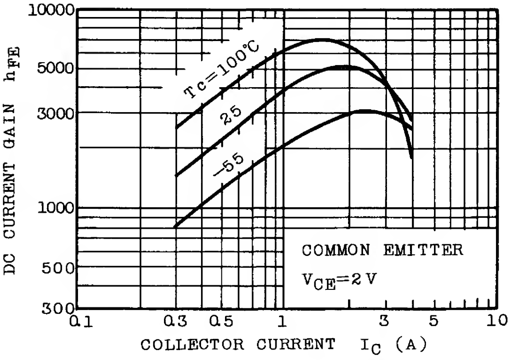
$I_C - V_{CE}$



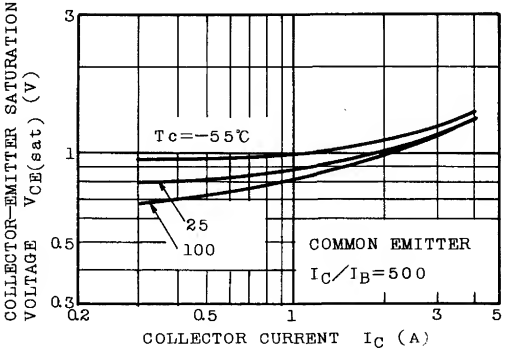
$I_C - V_{BE}$

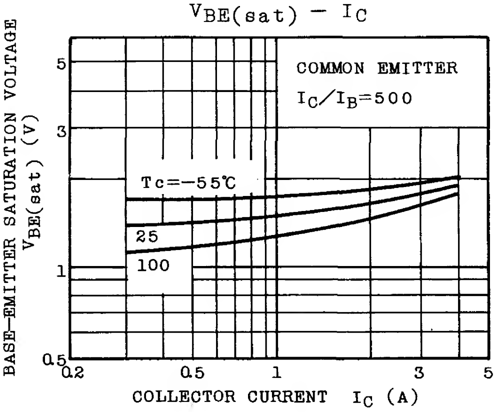


$h_{FE} - I_C$

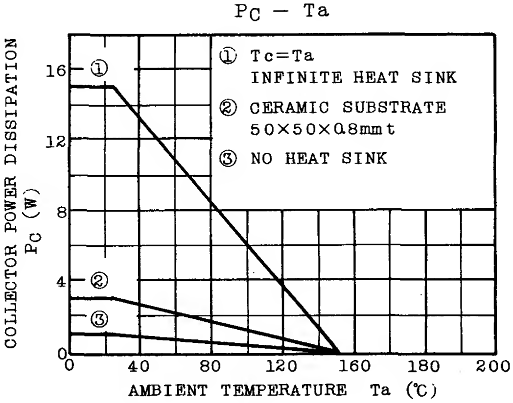


$V_{CE(sat)} - I_C$

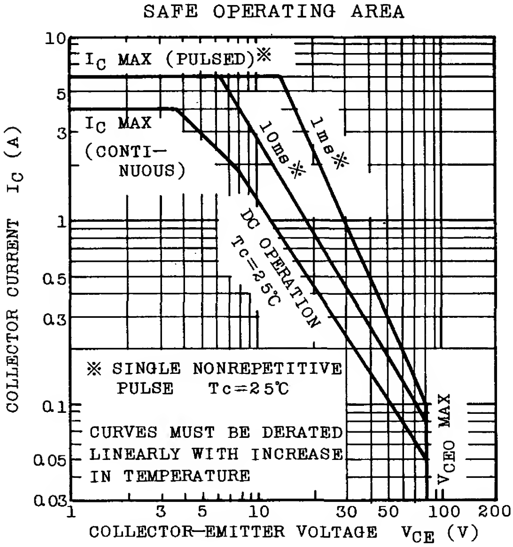




$V_{BE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA

2SD1224

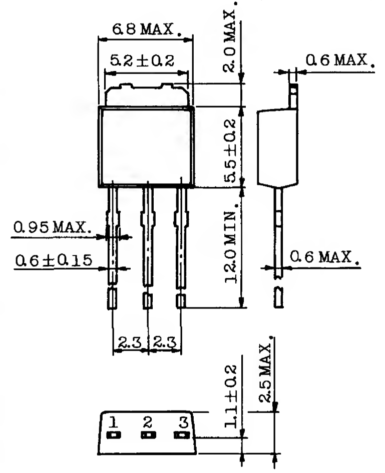
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

PULSE MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=4000(Min.) (V_{CE}=2V, I_C=150mA)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=1A, I_B=1mA)

Unit in mm



1. BASE
2. COLLECTOR (FIN)
3. EMITTER

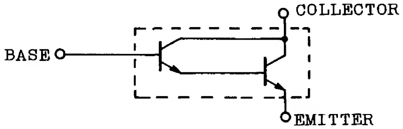
JEDEC	—
EIAJ	—
TOSHIBA	2-7B1A

Weight : 0.36g

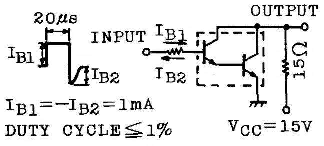
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	30	V
Collector-Emitter Voltage		V_{CEO}	30	V
Emitter-Base Voltage		V_{EBO}	10	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.15	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

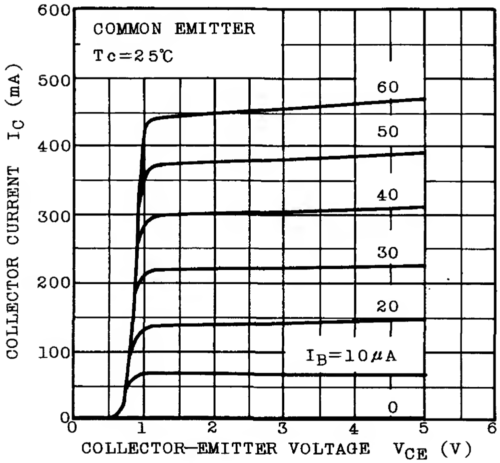
EQUIVALENT CIRCUIT



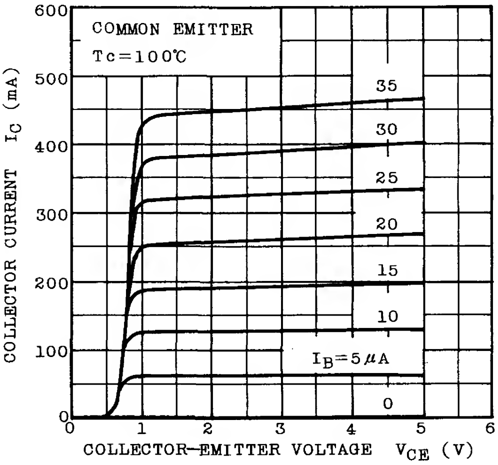
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=10V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	30	-	-	V
DC Current Gain		h_{FE}	V_{CE}=2V, I_C=150mA	4000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=1A, I_B=1mA	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=1A, I_B=1mA	-	-	2.2	
Switching Time	Turn-on Time	t_{on}	 20μs, INPUT, I_{B1}, I_{B2}, OUTPUT, 15Ω I_{B1}=$-I_{B2}$=1mA DUTY CYCLE≦1% V_{CC}=15V	-	0.18	-	μs
	Storage Time	t_{stg}		-	0.6	-	
	Fall Time	t_f		-	0.3	-	

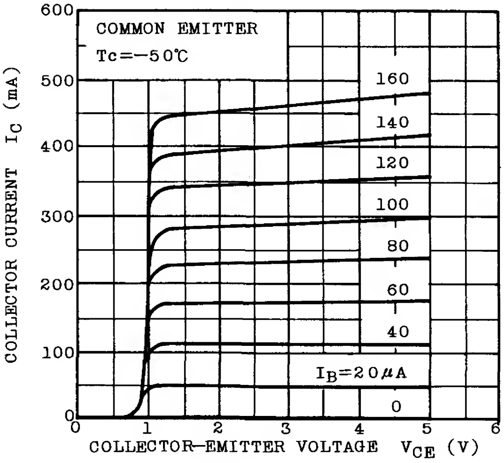
$I_C - V_{CE}$



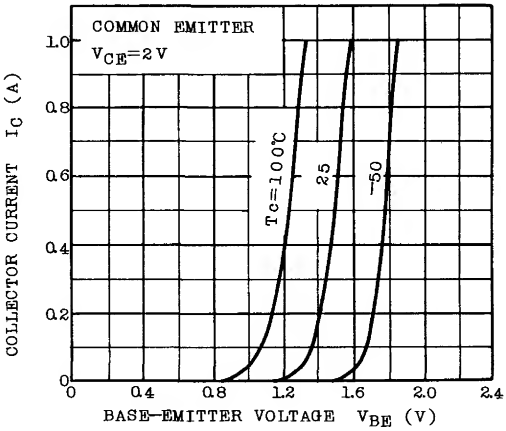
$I_C - V_{CE}$



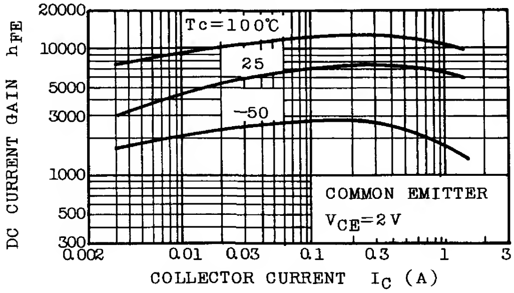
$I_C - V_{CE}$



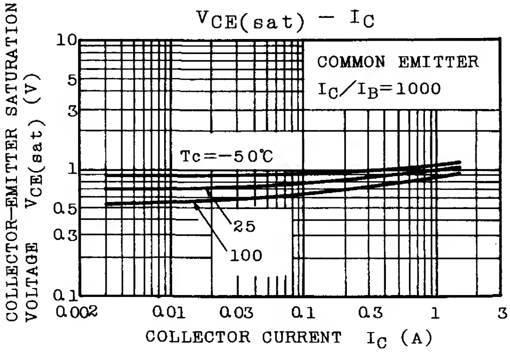
$I_C - V_{BE}$

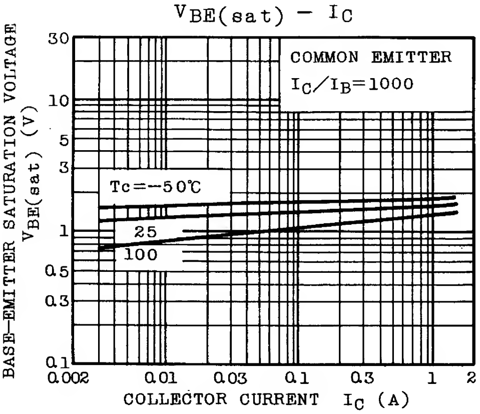


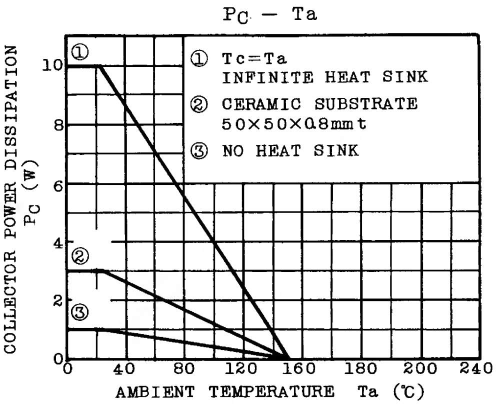
$h_{FE} - I_C$

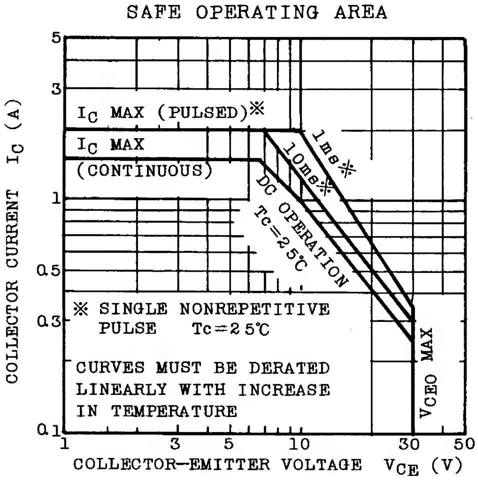


$V_{CE(sat)} - I_C$




VBE(sat) – IC
COMMON EMITTER
IC/IB=1000
Tc=−50℃
25
100
BASE–EMITTER SATURATION VOLTAGE VBE(sat) (V)
30
10
5
3
1
0.5
0.3
0.1
0.002
0.01
0.03
0.1
0.3
1
2
COLLECTOR CURRENT IC (A)


PC – Ta
① Tc=Ta INFINITE HEAT SINK
② CERAMIC SUBSTRATE 50×50×0.8mm t
③ NO HEAT SINK
①
②
③
COLLECTOR POWER DISSIPATION PC (W)
10
8
6
4
2
0
0
40
80
120
160
180
200
240
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
DC OPERATION Tc=25℃
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
5
3
1
0.5
0.3
0.1
1
3
5
10
30
50
COLLECTOR–EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

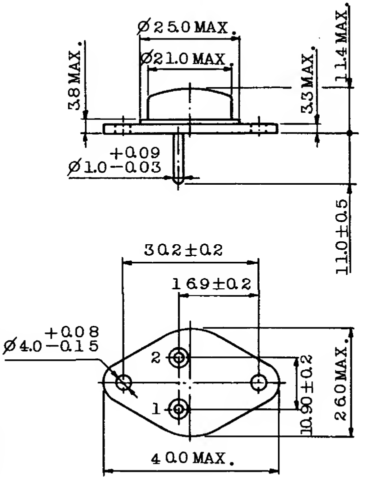
2SD1279

COLOR TV HORIZ. DEFLECTION OUTPUT APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1400V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V(Max.) (I_C=8A, I_B=2A)
- High Speed : t_f=1.0μs(Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR(CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Weight : 17.0g

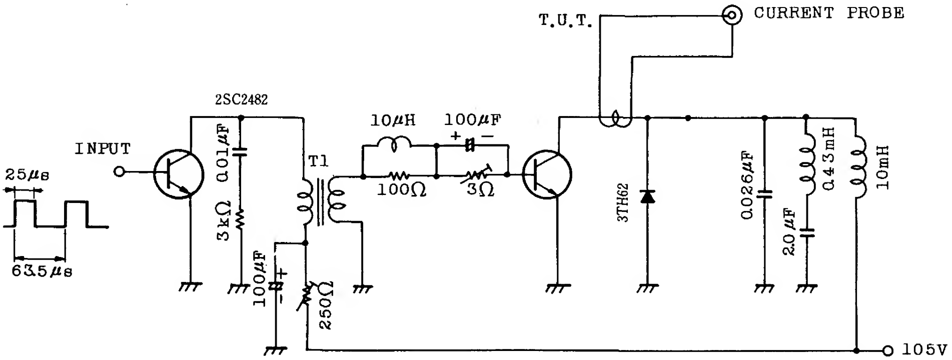
MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1400	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

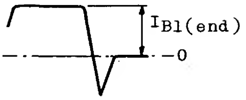
ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=2A	8	22	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=8A, I_B=2A	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=8A, I_B=2A	-	-	1.6	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Collector Current Fall Time	t_f	I_{CP}=7A, $I_{B1(end)}$=1.5A (Fig.)	-	-	1.0	μs

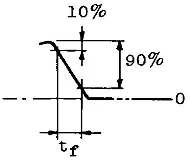
Fig. t_f TEST CIRCUIT



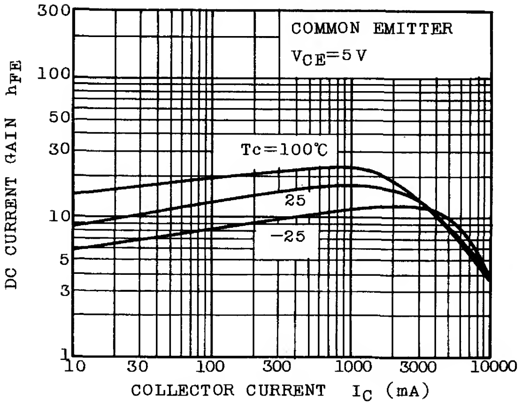
BASE CURRENT



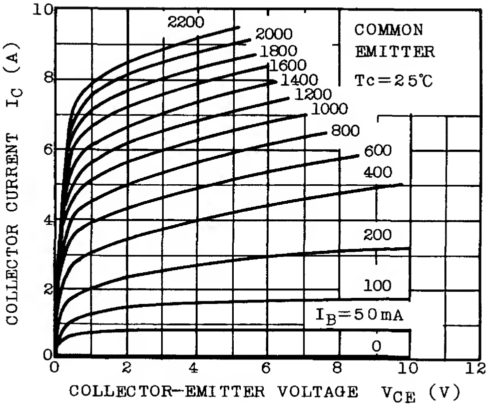
COLLECTOR CURRENT

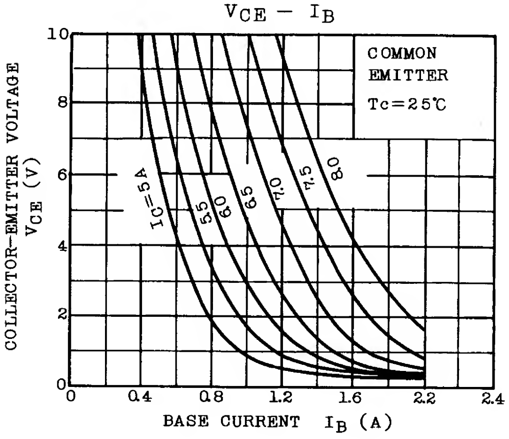


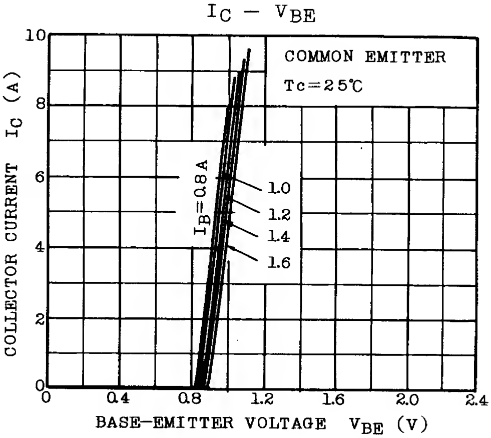
h_{FE} – I_C

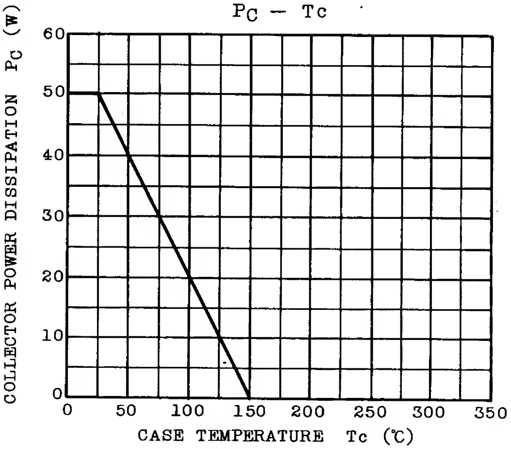


I_C – V_{CE}




VCE — IB
COMMON EMITTER
Tc=25℃
IC=5A
5.5
6.0
6.5
7.0
7.5
8.0
COLLECTOR-EMITTER VOLTAGE VCE (V)
BASE CURRENT IB (A)
0
2
4
6
8
10
0
0.4
0.8
1.2
1.6
2.2
2.4


IC — VBE
COMMON EMITTER
Tc=25℃
IB=0.8A
1.0
1.2
1.4
1.6
COLLECTOR CURRENT IC (A)
BASE-EMITTER VOLTAGE VBE (V)
0
2
4
6
8
10
0
0.4
0.8
1.2
1.6
2.0
2.4


PC — Tc
COLLECTOR POWER DISSIPATION PC (W)
CASE TEMPERATURE Tc (℃)
0
10
20
30
40
50
60
0
50
100
150
200
250
300
350

2SD1294

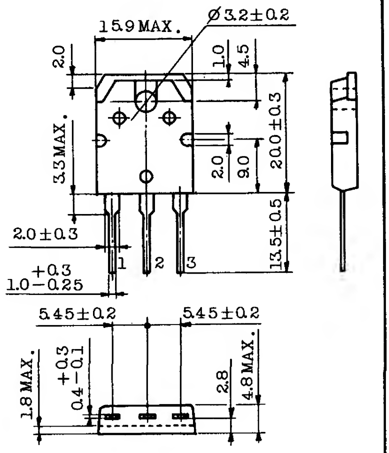
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)
(DARLINGTON POWER)

POWER REGULATOR FOR LINE OPERATED TV.

FEATURES:

- Excellent Wide Safe Operating Area (80 W.sec at $T_c=25^\circ C$)
- Included Abalanche Diode : $V_Z=60\pm15V$
- High DC Current Gain : $h_{FE}=2000\sim20000$
- Darlington Connected Type.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

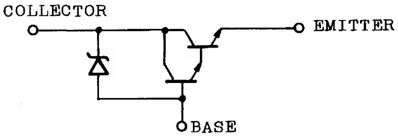
JEDEC	−
EIAJ	−
TOSHIBA	2−16B1A

Weight : 4.6g

MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60±15	V
Collector-Emitter Voltage	V_{CEO}	60±15	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current (Continous)	I_C	5	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

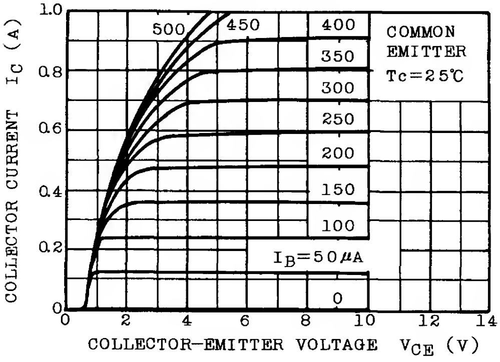
EQUIVALENT CIRCUIT



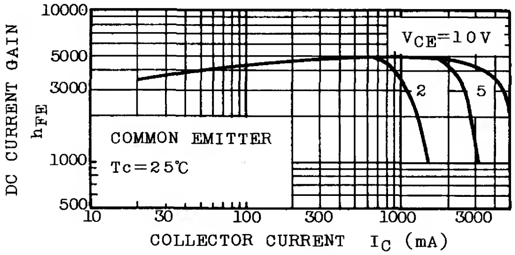
ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA,\ I_E=0$	45	60	75	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA,\ I_B=0$	45	60	75	V
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V,\ I_C=0$	-	-	100	μA
DC Current Gain	h_{FE}	$V_{CE}=5V,\ I_C=0.5A$	2000	-	20000	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (1)	$I_C=0.5A,\ I_B=1mA$	-	-	1.5	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (2)	$I_C=1A,\ I_B=1mA$	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V,\ I_C=0.5A$	-	-	1.8	V
Allowable Energy	E_T	Application Circuit	80	-	-	W·sec

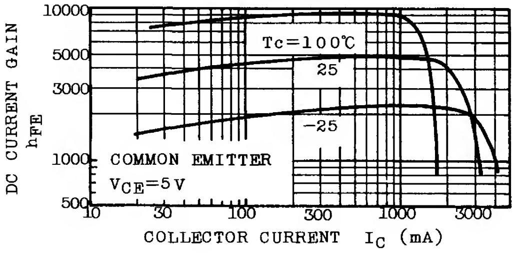
V_{CE} — I_C



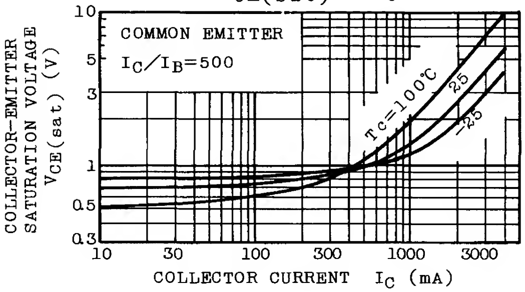
h_{FE} — I_C



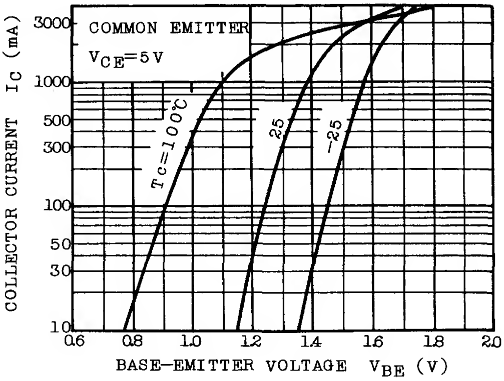
h_{FE} — I_C



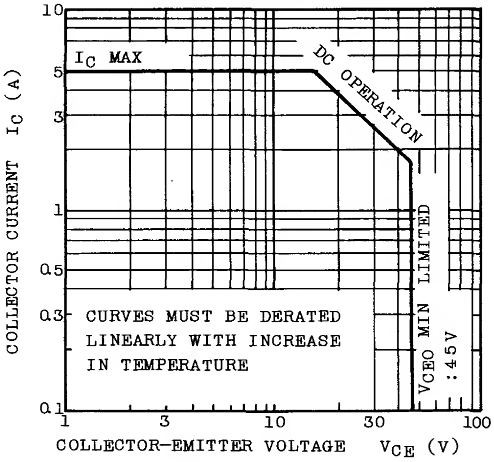
$V_{CE(sat)}$ — I_C



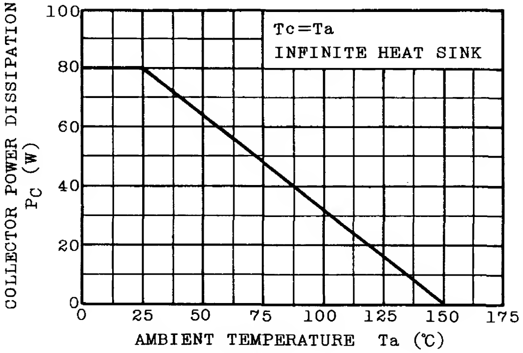
I_C — V_{BE}



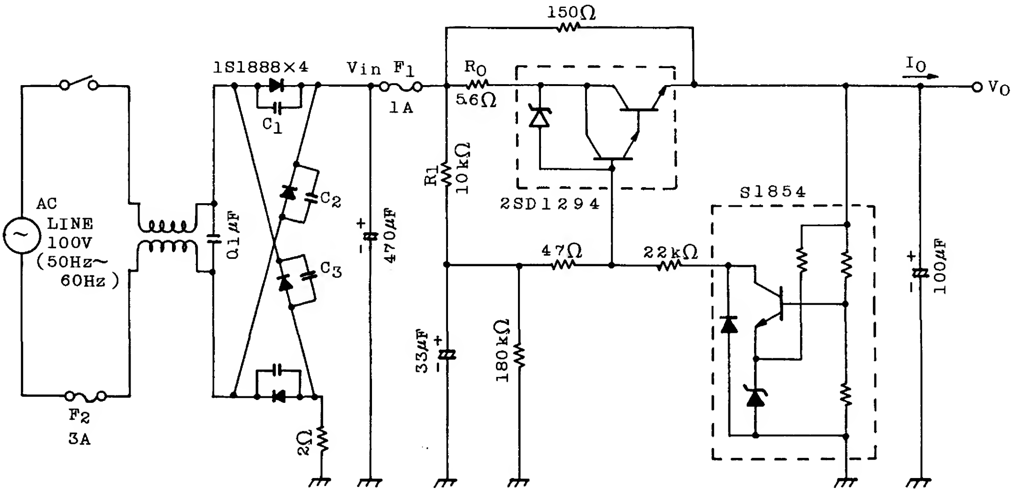
SAFE OPERATING AREA



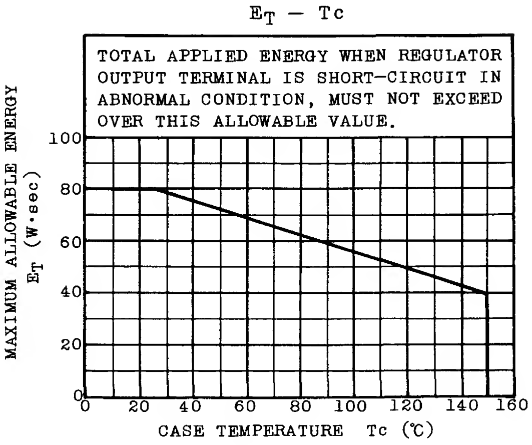
P_C — Ta



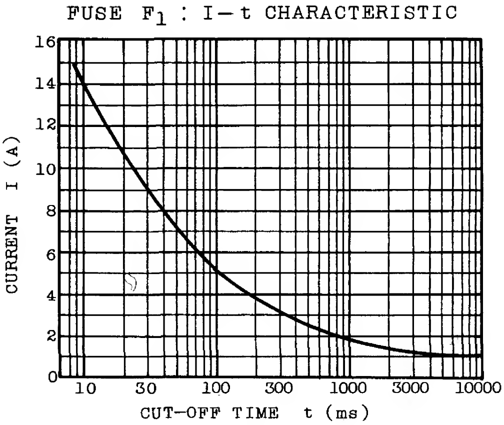
APPLICATION CIRCUIT



C1, C2, C3, C4 : 0.0047μF



TOTAL APPLIED ENERGY WHEN REGULATOR OUTPUT TERMINAL IS SHORT-CIRCUIT IN ABNORMAL CONDITION, MUST NOT EXCEED OVER THIS ALLOWABLE VALUE.



SILICON NPNTRIPLE DIFFUSED TYPE (PCT PROCESS)

2SD1313

HIGH POWER AMPLIFIER APPLICATIONS.

HIGH POWER SWITCHING APPLICATIONS.

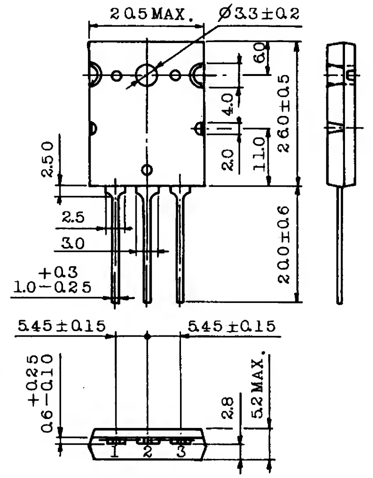
FEATURES:

. High Power Dissipation : P_C=200W (T_c=25°C)
. High Collector Current : I_C=25A (DC)
. High Speed Switching : t_f=0.5μs(Typ.)(I_C=15A)
. Low Saturation Voltage : $V_{CE(sat)}$=1.0V(Max.)(I_C=15A)

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	800	V
Collector-Emitter Voltage		V_{CEO}	350	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	25	A
	Pulse	I_{CP}	35	
Base Current	DC	I_B	10	A
	Pulse	I_{BP}	15	
Collector Power Dissipation (T_c=25°C)		P_C	200	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

Unit in mm

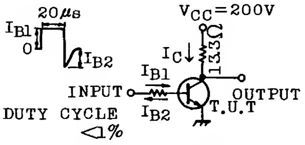


1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

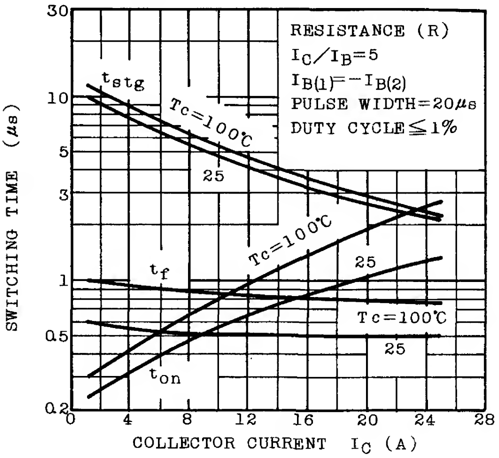
JEDEC	−
EIAJ	−
TOSHIBA	2−21F1A

Weight : 9.75g

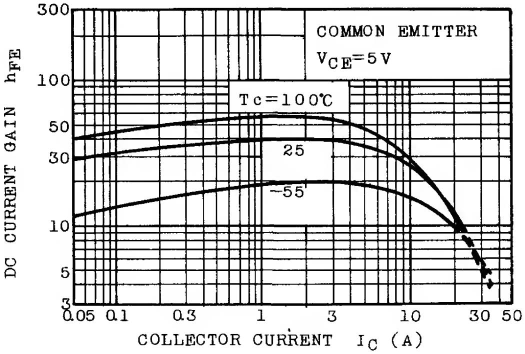
ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=800V, I_E=0	-	-	1	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	350	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=1A	15	-	-	
		$h_{FE(2)}$	V_{CE}=5V, I_C=25A	6	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=15A, I_B=3A	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=15A, I_B=3A	-	-	1.7	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	170	-	pF
Transition Frequency		f_T	V_{CE}=10V, I_E=1A	-	6	-	MHz
Switching Time	Turn-on Time	t_{on}	 I_C=15A, I_{B1}=−I_{B2}=3A	-	0.8	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.5	-	

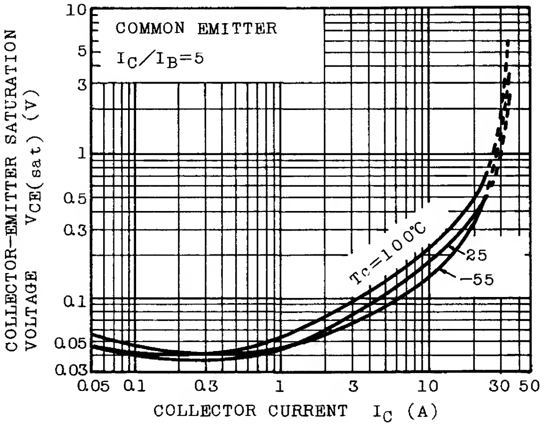
SWITCHING APPLICATIONS



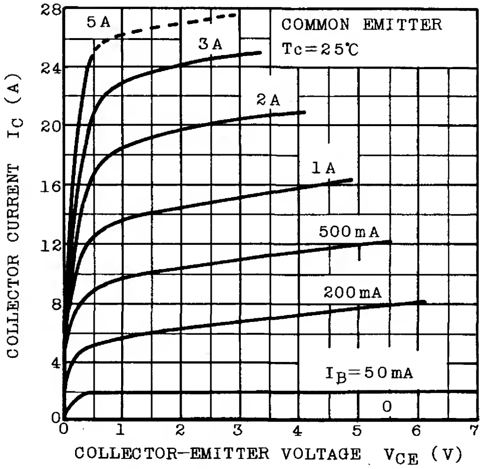
h_{FE} − I_C



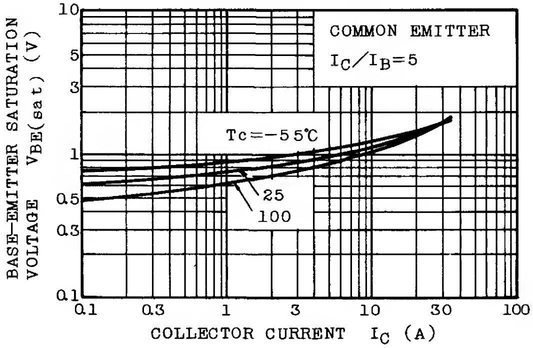
$V_{CE(sat)}$ − I_C

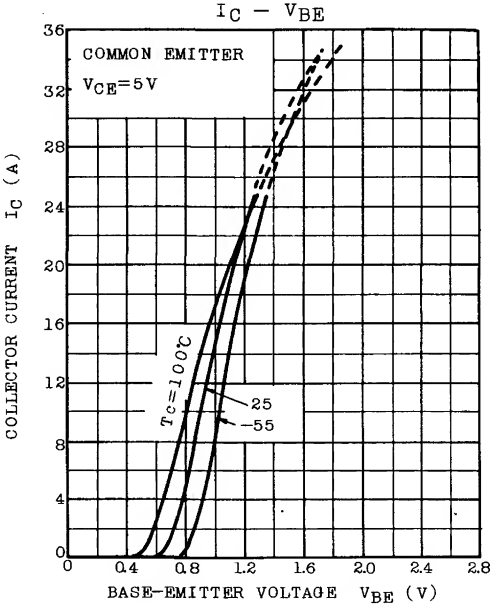


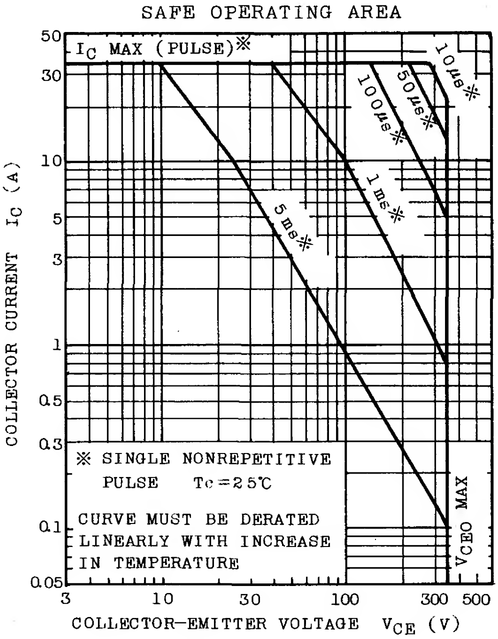
I_C − V_{CE}



$V_{BE(sat)}$ − I_C




I_C — V_{BE}
COMMON EMITTER
V_{CE}=5V
Tc=100°C
25
−55
COLLECTOR CURRENT I_C (A)
36
32
28
24
20
16
12
8
4
0
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
BASE−EMITTER VOLTAGE V_{BE} (V)


SAFE OPERATING AREA
I_C MAX (PULSE)※
10μs※
50μs※
100μs※
1ms※
5ms※
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVE MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX
COLLECTOR CURRENT I_C (A)
50
30
10
5
3
1
0.5
0.3
0.1
0.05
3
10
30
100
300
500
COLLECTOR−EMITTER VOLTAGE V_{CE} (V)

2SD1314

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

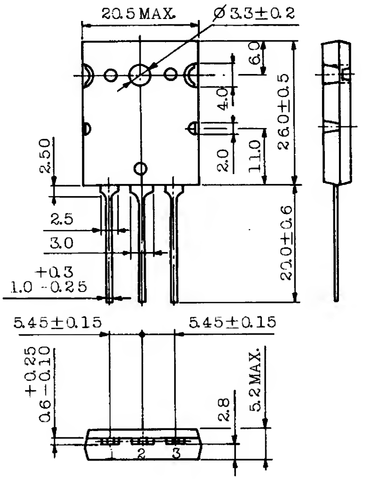
HIGH POWER SWITCHING APPLICATIONS.

MOTOR CONTROL APPLICATIONS.

Unit in mm

FEATURES:

- High DC Current Gain : h_{FE}=100(Min.) (I_C=15A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.) (I_C=15A)
- High Speed : t_f=3μs(Max.) (I_C=15A)



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

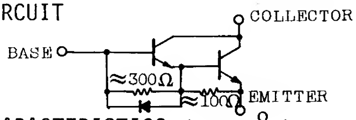
JEDEC	−
EIAJ	−
TOSHIBA	2−21F1A

Weight : 9.75g

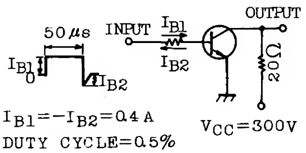
MAXIMUM RATINGS (Tc=25°C)

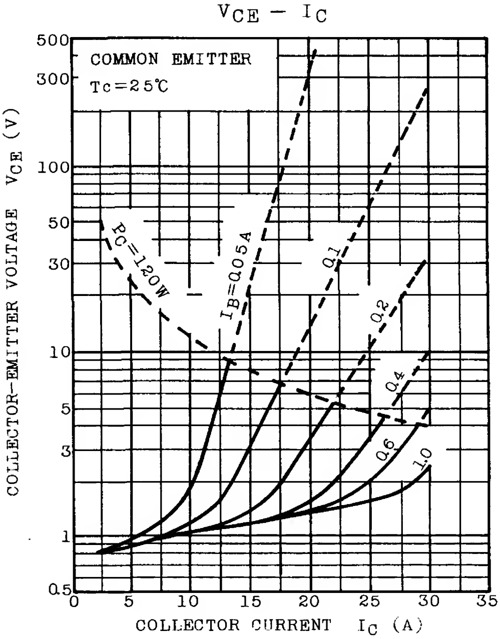
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	15	A
	1ms	I_C	30	
Base Current		I_B	1	A
Collector Power Dissipation (Tc=25°C)		P_C	150	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−40 ~150	°C

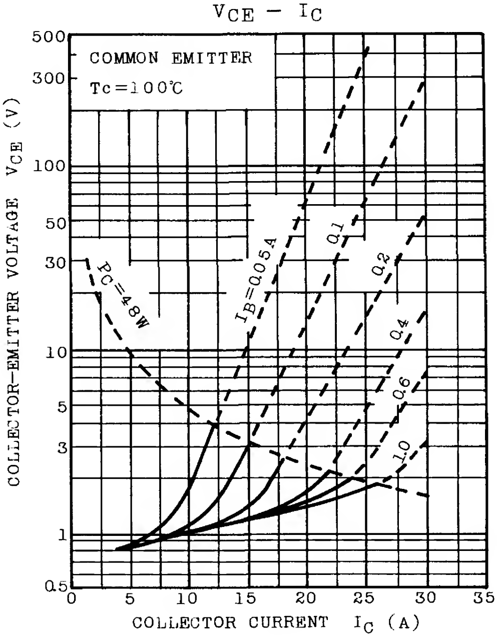
EQUIVALENT CIRCUIT

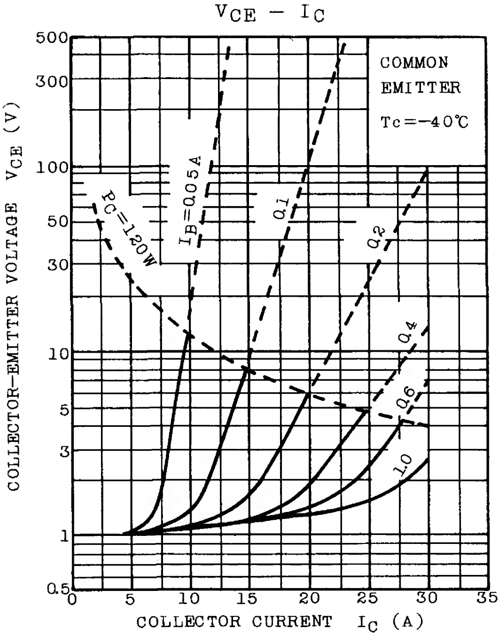


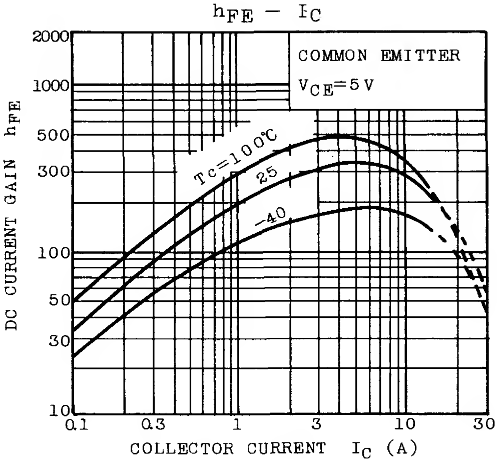
ELECTRICAL CHARACTERISTICS (Ta=25°C)

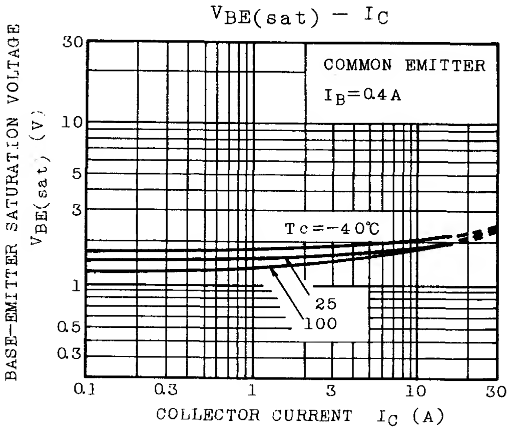
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	−	−	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	−	−	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	−	−	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=15A	100	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=15A, I_B=0.4A	−	−	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		−	−	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	−	150	−	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=−I_{B2}=0.4A DUTY CYCLE=0.5% V_{CC}=300V	−	−	1.0	μs
	Storage Time	t_{stg}		−	−	12	
	Fall Time	t_f		−	−	3.0	

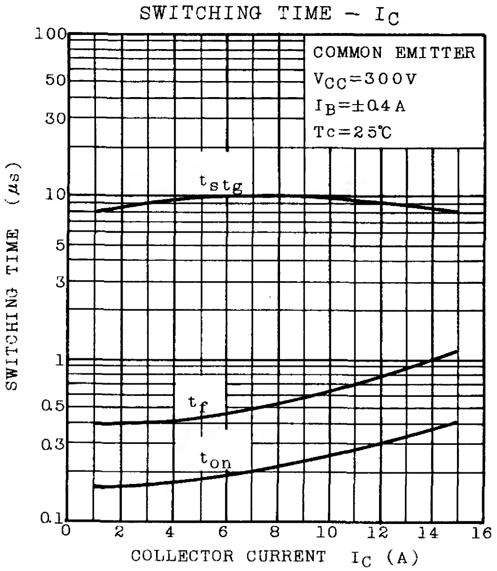

VCE − IC
COMMON EMITTER
Tc=25℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
PC=120W
IB=0.05A
0.1
0.2
0.4
0.6
1.0
500
300
100
50
30
10
5
3
1
0.5
0
5
10
15
20
25
30
35

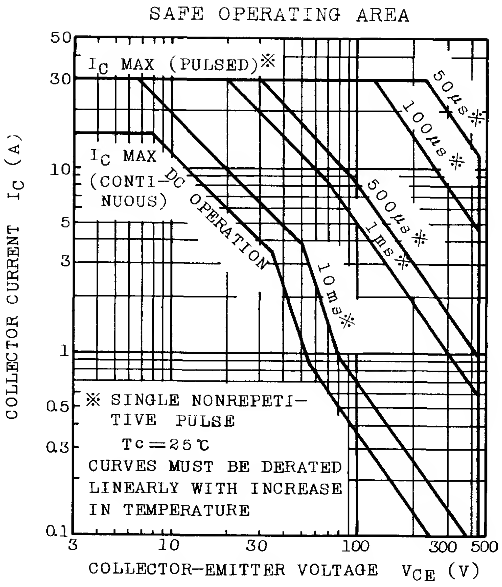

VCE − IC
COMMON EMITTER
Tc=100℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
PC=48W
IB=0.05A
0.1
0.2
0.4
0.6
1.0
500
300
100
50
30
10
5
3
1
0.5
0
5
10
15
20
25
30
35


VCE − IC
COMMON
EMITTER
Tc=−40℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
PC=120W
IB=0.05A
0.1
0.2
0.4
0.6
1.0
500
300
100
50
30
10
5
3
1
0.5
0
5
10
15
20
25
30
35


hFE − IC
COMMON EMITTER
VCE=5V
DC CURRENT GAIN hFE
COLLECTOR CURRENT IC (A)
Tc=100℃
25
−40
2000
1000
500
300
100
50
30
10
0.1
0.3
1
3
10
30


$V_{BE(sat)}$ – I_C
COMMON EMITTER
I_B=0.4A
Tc=−40℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
30
10
5
3
1
0.5
0.3
0.1
0.3
1
3
10
30
COLLECTOR CURRENT I_C (A)


SWITCHING TIME – I_C
COMMON EMITTER
V_{CC}=300V
I_B=±0.4A
Tc=25℃
t_{stg}
t_f
t_{on}
SWITCHING TIME (μs)
100
50
30
10
5
3
1
0.5
0.3
0.1
0
2
4
6
8
10
12
14
16
COLLECTOR CURRENT I_C (A)


SAFE OPERATING AREA
I_C MAX (PULSED)※
I_C MAX (CONTI-NUOUS)
DC OPERATION
50μs※
100μs※
500μs※
1ms※
10ms※
※ SINGLE NONREPETITIVE PULSE
Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT I_C (A)
50
30
10
5
3
1
0.5
0.3
0.1
3
10
30
100
300
500
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED TYPE

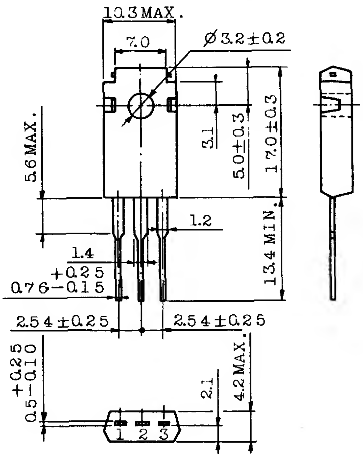
2SD1353

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain of 200 to 1200 at V_{CE}=5V, I_C=0.5A
- Low $V_{CE(sat)}$ of 1.0V (Max.) at I_C=1A, I_B=0.02A
- Collector Power Dissipation of 30W at Tc=25°C

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

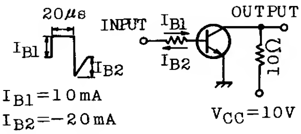
JEDEC	–
EIAJ	–
TOSHIBA	2–10K1A

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

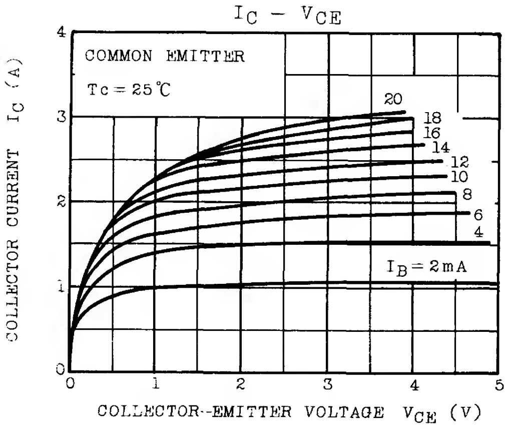
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

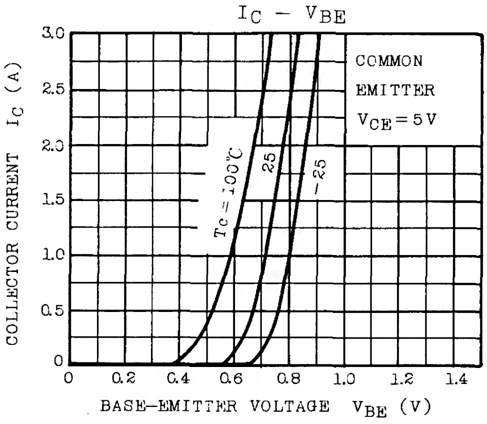
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=0.5A	200	-	1200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.02A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	5.0	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} I_{B1} I_{B2} OUTPUT 10Ω V_{CC}=10V I_{B1}=10mA I_{B2}=−20mA DUTY CYCLE<1%	-	2.0	-	μs
	Storage Time	t_{stg}		-	5.0	-	
	Fall Time	t_f		-	3.0	-	

Note : h_{FE} Classification GR : 200～400, BL : 350～700, V : 600～1200

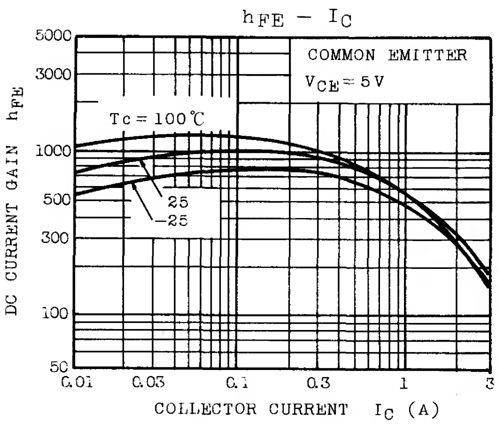
2SD1353



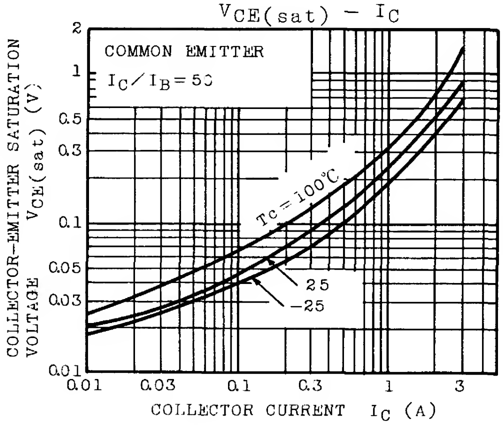
$I_C - V_{CE}$
COMMON EMITTER
Tc = 25℃
20
18
16
14
12
10
8
6
4
I_B = 2mA
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
0
1
2
3
4
5



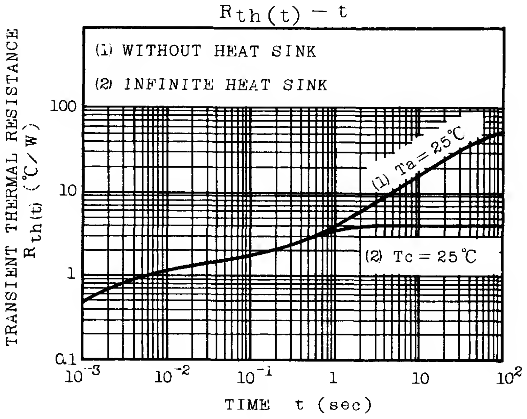
$I_C - V_{BE}$
COMMON EMITTER
V_{CE} = 5V
Tc = 100℃
25
−25
COLLECTOR CURRENT I_C (A)
0
0.5
1.0
1.5
2.0
2.5
3.0
BASE-EMITTER VOLTAGE V_{BE} (V)
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4



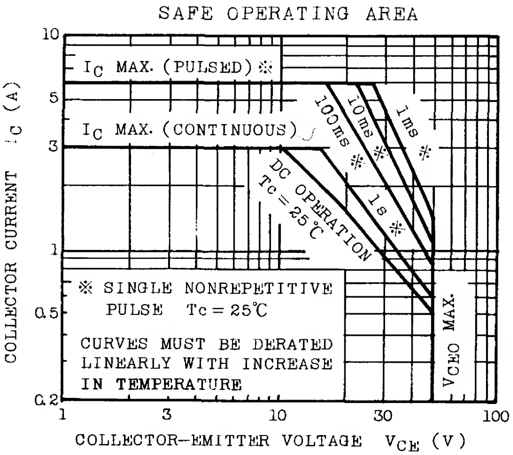
$h_{FE} - I_C$
COMMON EMITTER
V_{CE} = 5V
Tc = 100℃
25
−25
DC CURRENT GAIN h_{FE}
50
100
300
500
1000
3000
5000
COLLECTOR CURRENT I_C (A)
0.01
0.03
0.1
0.3
1
3



$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B = 50
Tc = 100℃
25
−25
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0.01
0.03
0.05
0.1
0.3
0.5
1
2
COLLECTOR CURRENT I_C (A)
0.01
0.03
0.1
0.3
1
3



$R_{th(t)} - t$
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1) Ta = 25℃
(2) Tc = 25℃
TRANSIENT THERMAL RESISTANCE $R_{th(t)}$ (℃/W)
0.1
1
10
100
TIME t (sec)
10^{-3}
10^{-2}
10^{-1}
1
10
10^2



SAFE OPERATING AREA
I_C MAX. (PULSED) ※
I_C MAX. (CONTINUOUS)
100ms ※
10ms ※
1ms ※
1s ※
DC OPERATION
Tc = 25℃
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
0.2
0.5
1
3
5
10
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
1
3
10
30
100

SILICON NPN TRIPLE DIFFUSED TYPE

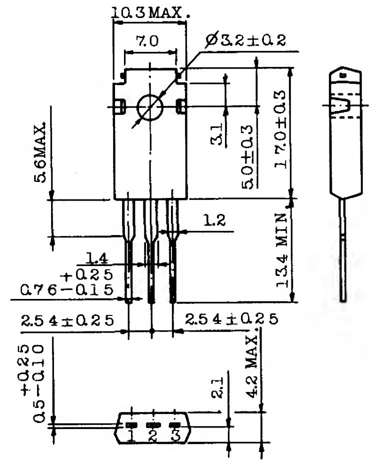
2SD1354

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain : h_{FE}=300(Max.)(V_{CE}=5V, I_C=0.5A)
- Low Saturation Voltage : $V_{CE(sat)}$=1.0V(Max.)(I_C=3A, I_B=0.3A)
- High Power Dissipation : P_C=30W (Tc=25°C)
- Complementary to 2SB994

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

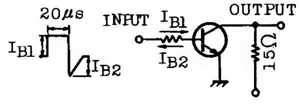
JEDEC	–
EIAJ	–
TOSHIBA	2−10K1A

Weight : 2.0g

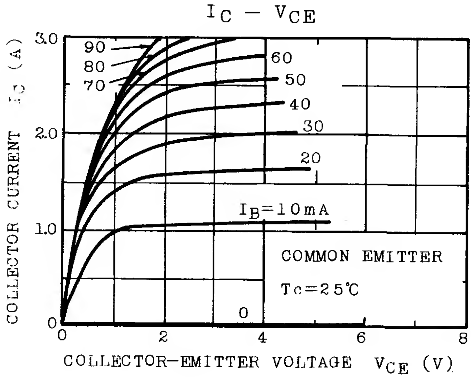
MAXIMUM RATINGS (Ta=25°C)

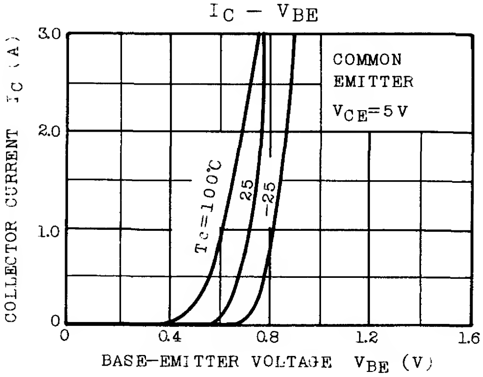
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

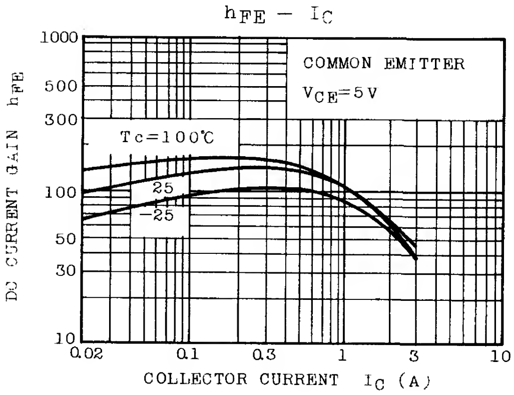
ELECTRICAL CHARACTERISTICS (Ta=25°C)

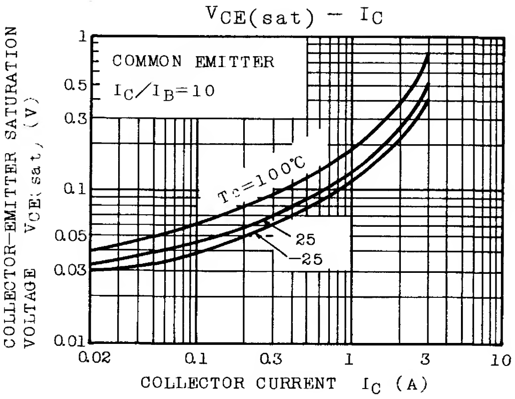
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	60	-	-	V
DC Current Gain		h_{FE}(Note)	V_{CE}=5V, I_C=0.5A	60	-	300	
Collector Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	3.0	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B1} I_{B2} I_{B2} OUTPUT 15Ω I_{B1}=−I_{B2}=0.2A V_{CC}=30V DUTY CYCLE<1%	-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

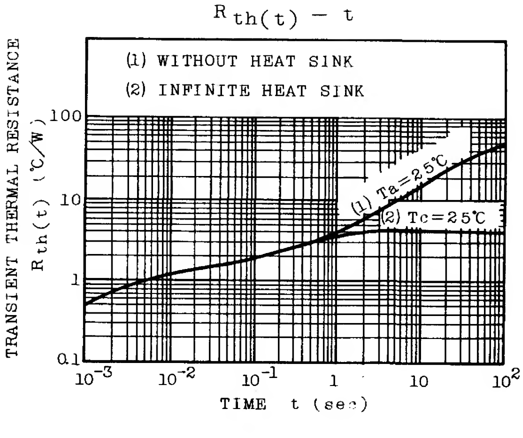
Note : h_{FE} Classification O : 60 ~ 120, Y : 100 ~ 200, GR : 150 ~ 300

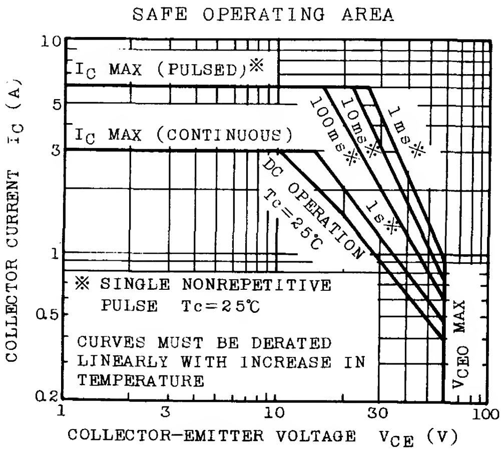

IC − VCE
COLLECTOR CURRENT IC (A)
COLLECTOR−EMITTER VOLTAGE VCE (V)
90
80
70
60
50
40
30
20
IB=10mA
0
COMMON EMITTER
Tc=25℃
3.0
2.0
1.0
0
2
4
6
8


IC − VBE
COLLECTOR CURRENT IC (A)
BASE−EMITTER VOLTAGE VBE (V)
COMMON EMITTER
VCE=5V
Tc=100℃
25
−25
3.0
2.0
1.0
0
0.4
0.8
1.2
1.6


hFE − IC
DC CURRENT GAIN hFE
COLLECTOR CURRENT IC (A)
COMMON EMITTER
VCE=5V
Tc=100℃
25
−25
1000
500
300
100
50
30
10
0.02
0.1
0.3
1
3
10


VCE(sat) − IC
COLLECTOR−EMITTER SATURATION VOLTAGE VCE(sat) (V)
COLLECTOR CURRENT IC (A)
COMMON EMITTER
IC/IB=10
Tc=100℃
25
−25
1
0.5
0.3
0.1
0.05
0.03
0.01
0.02
0.1
0.3
1
3
10


Rth(t) − t
TRANSIENT THERMAL RESISTANCE Rth(t) (℃/W)
TIME t (sec)
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1) Ta=25℃
(2) Tc=25℃
100
10
1
0.1
10^-3
10^-2
10^-1
1
10
10^2

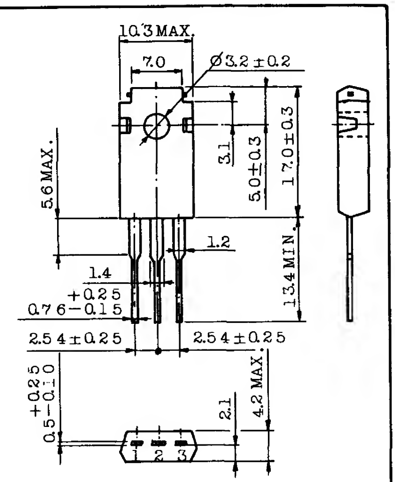

SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
COLLECTOR−EMITTER VOLTAGE VCE (V)
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
100ms※
10ms※
1ms※
1s※
DC OPERATION Tc=25℃
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
10
5
3
1
0.5
0.2
1
3
10
30
100

SILICON NPN TRIPLE DIFFUSED TYPE

2SD1355

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−10K1A

Weight : 2.0g

FEATURES:

- High Breakdown Voltage : V_{CEO}=100V
- Low Collector Saturation Voltage : $V_{CE(sat)}$=2.0V(Max.)
- Complementary to 2SB995
- Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

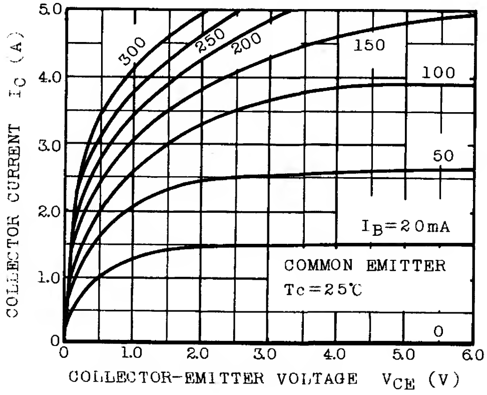
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

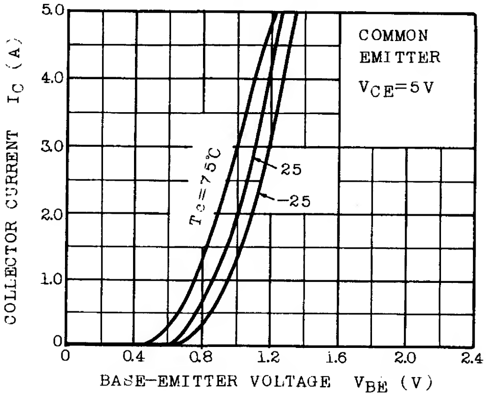
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=1A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	12	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

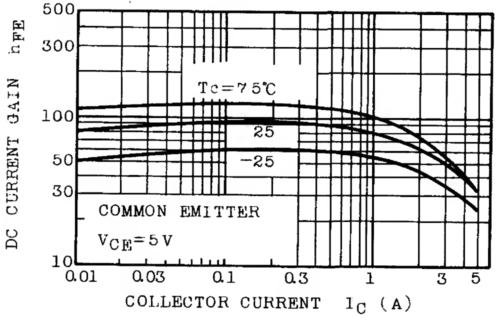
$I_C - V_{CE}$



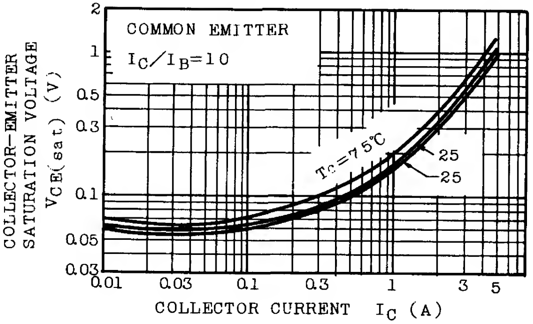
$I_C - V_{BE}$



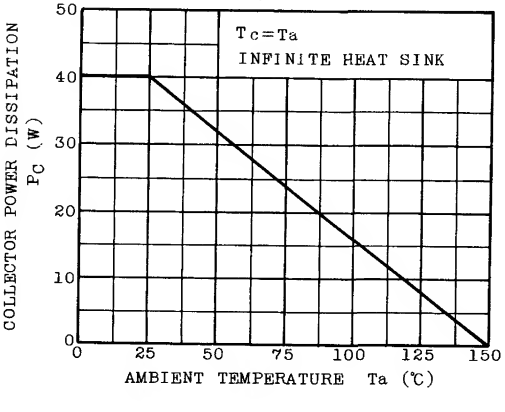
$h_{FE} - I_C$



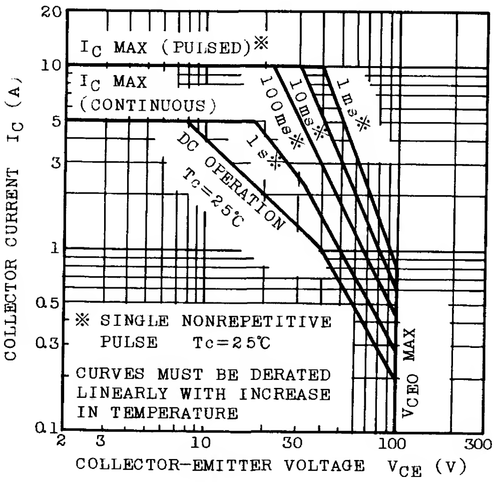
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE

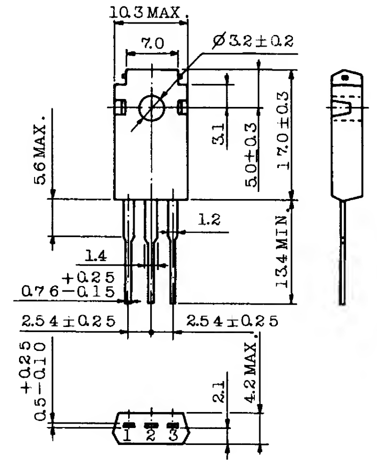
2SD1356

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : P_C=30W (Tc=25°C)
- Good Linearity of h_{FE}
- Complementary to 2SB996
- Recommended for 20～25W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

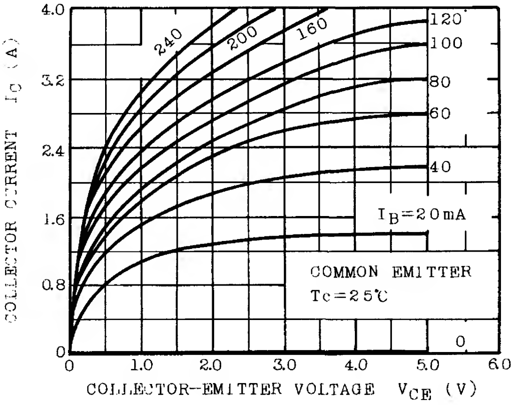
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Base Current	I_B	0.4	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

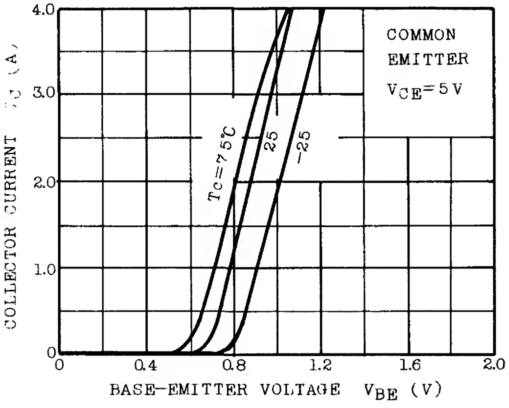
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=80V, I_E=0	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=3A	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=3A	-	1.0	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	-	8.0	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

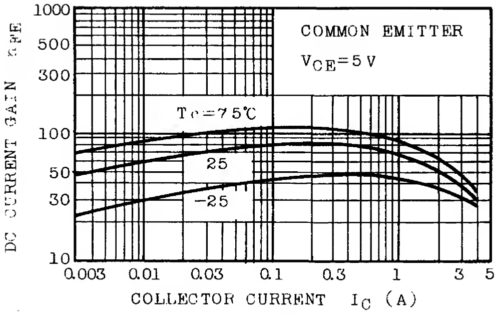
$I_C - V_{CE}$



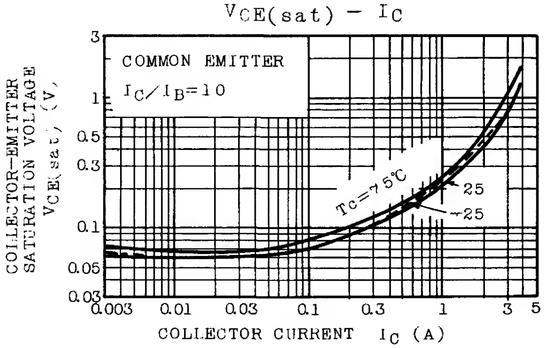
$I_C - V_{BE}$



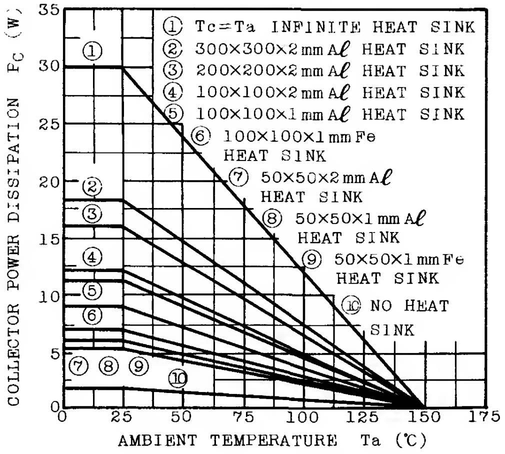
$h_{FE} - I_C$



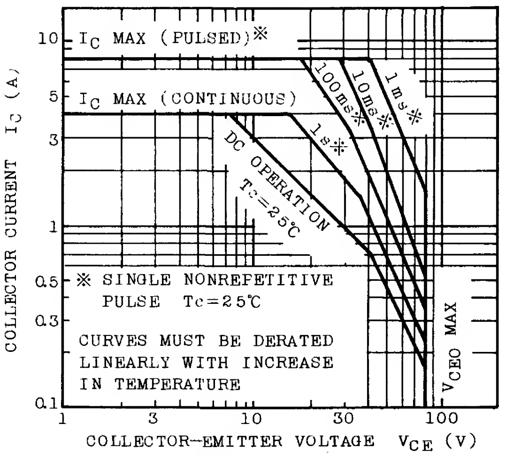
$V_{CE(sat)} - I_C$



$P_C - Ta$



SAFE OPERATING AREA



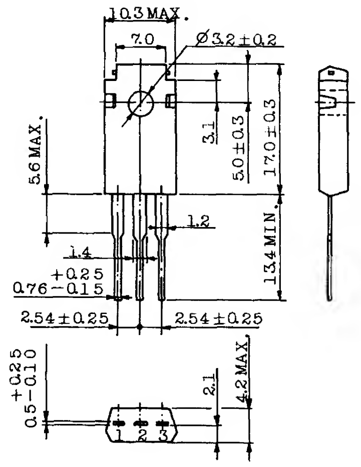
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD1357
2SD1358
2SD1359

HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-10K1A

Weight : 2.0g

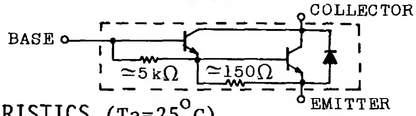
FEATURES:

- High DC Current Gain: h_{FE}=2000(Min.)(at V_{CE}=3V, I_C=3A)
- Low Saturation Voltage: $V_{CE(sat)}$=1.5V(Max.)(at I_C=3A)
- Complementary to 2SB997, 2SB998, 2SB999

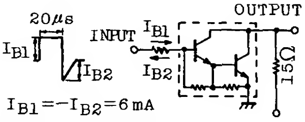
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD1357	V_{CBO}	100	V
	2SD1358		80	
	2SD1359		60	
Collector-Emitter Voltage	2SD1357	V_{CEO}	100	V
	2SD1358		80	
	2SD1359		60	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	0.2	A
Collector Power Dissipation (Tc=25°C)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

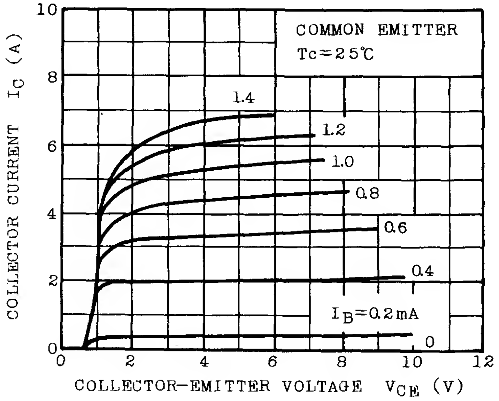
EQUIVALENT CIRCUIT



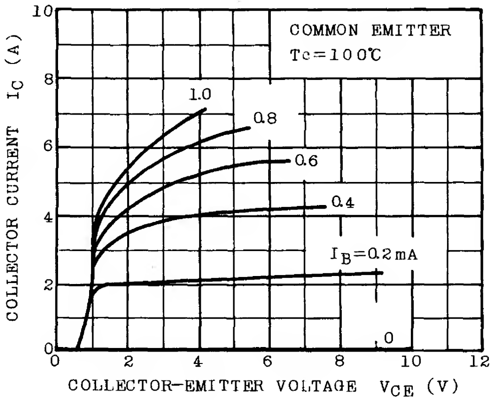
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		2SD1357	I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
		2SD1358		V_{CB}=80V, I_E=0	-	-	100	
		2SD1359		V_{CB}=60V, I_E=0	-	-	100	
Emitter Cut-off Current			I_{EBO}	V_{EB}=5V, I_C=0	-	-	3.0	mA
Collector-Emitter Breakdwon Voltage		2SD1357	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
		2SD1358			80	-	-	
		2SD1359			60	-	-	
DC Current Gain			$h_{FE}(1)$	V_{CE}=3V, I_C=3A	2000	-	15000	
			$h_{FE}(2)$	V_{CE}=3V, I_C=7A	1000	-	-	
Collector-Emitter Saturation Voltage			$V_{CE(sat)}(1)$	I_C=3A, I_B=6mA	-	0.9	1.5	V
			$V_{CE(sat)}(2)$	I_C=7A, I_B=14mA	-	1.2	2.0	
Base-Emitter Saturation Voltage			$V_{BE(sat)}$	I_C=3A, I_B=6mA	-	1.5	2.5	V
Switching Time	Turn-on Time		t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 15Ω I_{B1} I_{B2} I_{B1}=−I_{B2}=6mA DUTY CYCLE≦1% V_{CC}=45V	-	0.8	-	μs
	Storage Time		t_{stg}		-	3.0	-	
	Fall Time		t_f		-	2.5	-	

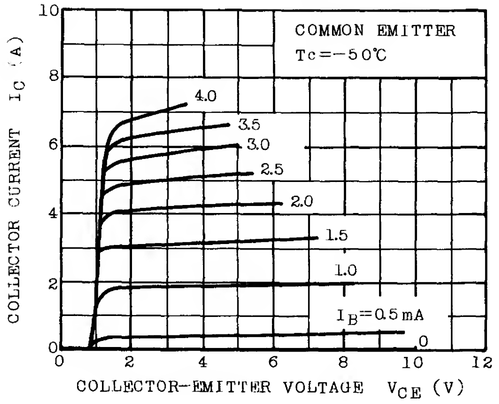
$I_C - V_{CE}$



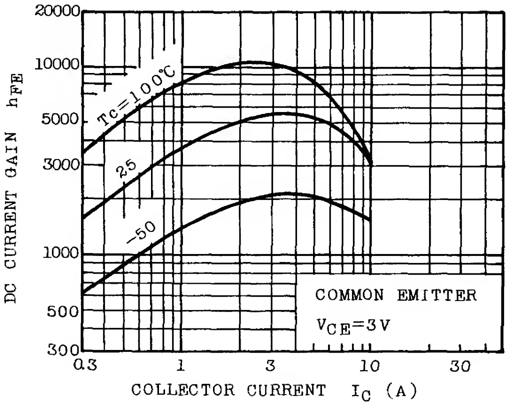
$I_C - V_{CE}$



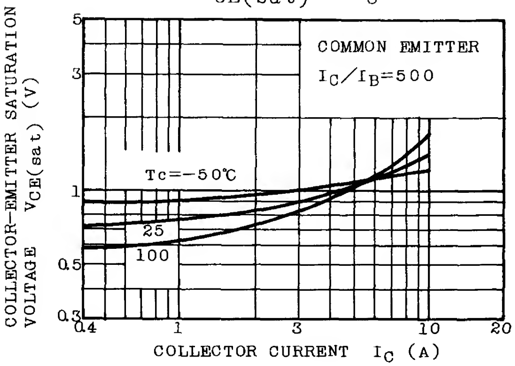
$I_C - V_{CE}$



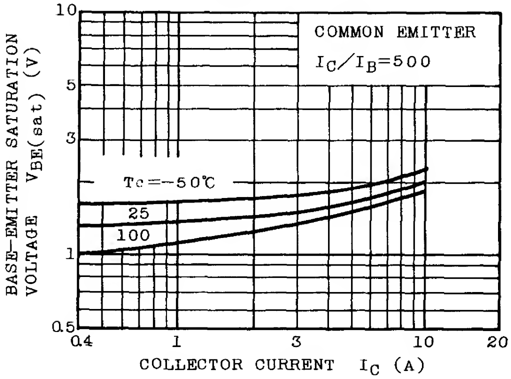
$h_{FE} - I_C$

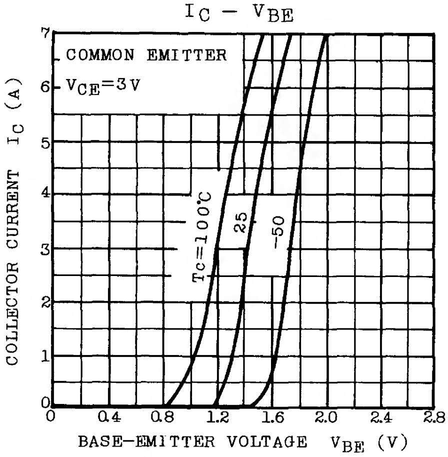


$V_{CE(sat)} - I_C$

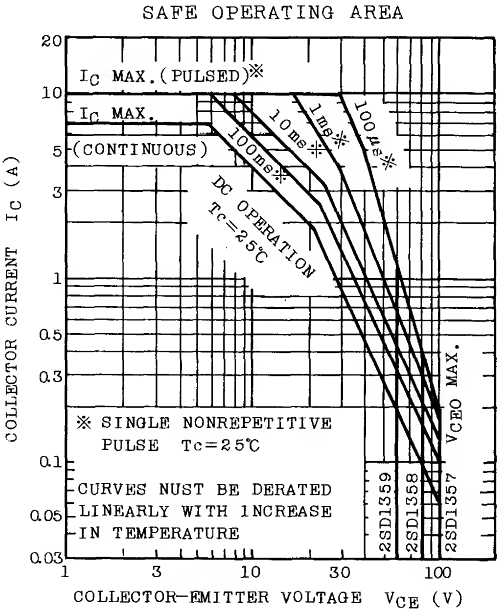


$V_{BE(sat)} - I_C$





IC – VBE
COMMON EMITTER
VCE=3V
Tc=100°C
25
-50
COLLECTOR CURRENT IC (A)
BASE–EMITTER VOLTAGE VBE (V)
0
1
2
3
4
5
6
7
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8



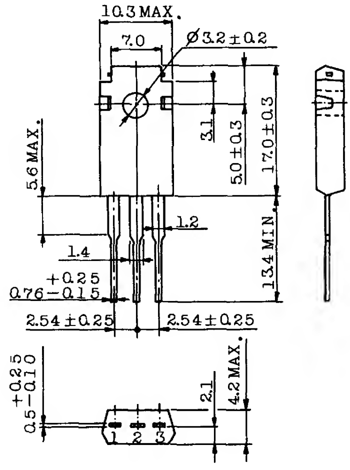
SAFE OPERATING AREA
IC MAX.(PULSED)※
IC MAX.
(CONTINUOUS)
10ms※
1ms※
100μs※
100ms※
DC OPERATION
Tc=25°C
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVES NUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX.
2SD1359
2SD1358
2SD1357
COLLECTOR CURRENT IC (A)
COLLECTOR–EMITTER VOLTAGE VCE (V)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.03
1
3
10
30
100

2SD1360

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2−10K1A

Weight : 2.0g

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

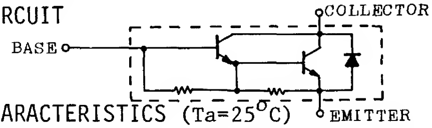
FEATURES:

- High DC Current Gain : h_{FE}=600(Min.)(at V_{CE}=2V, I_C=2A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

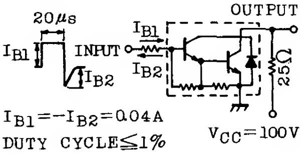
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

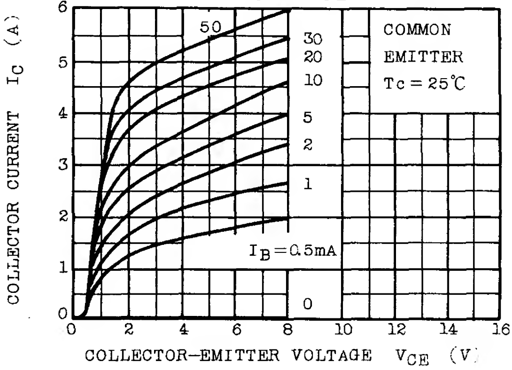
EQUIVALENT CIRCUIT



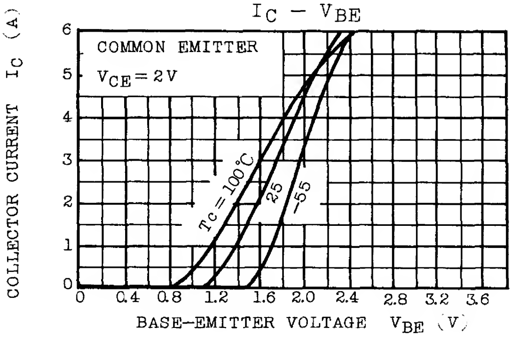
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	600	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	100	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	
Emitter-Collector Forward Voltage		V_{ECF}	I_E=4A, I_B=0	-	-	3.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs, I_{B1}, INPUT, I_{B2}, OUTPUT, 25Ω I_{B1}=−I_{B2}=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

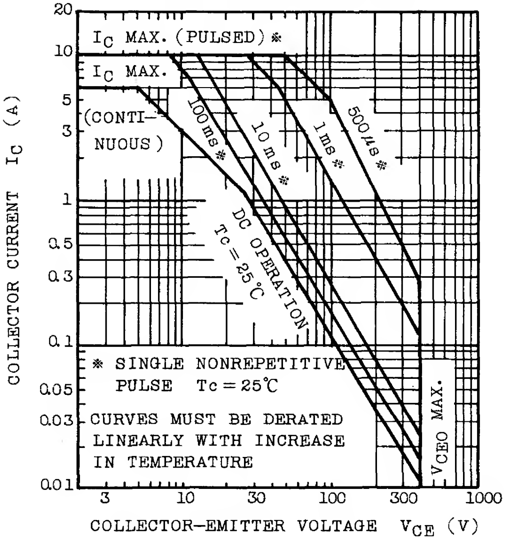
$I_C - V_{CE}$



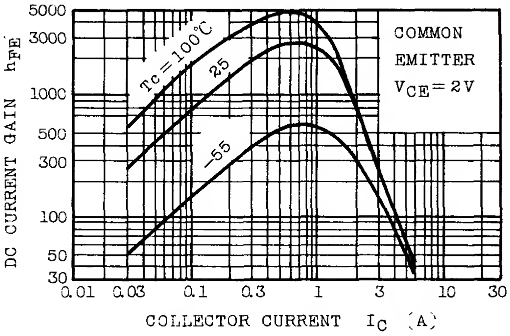
$I_C - V_{BE}$



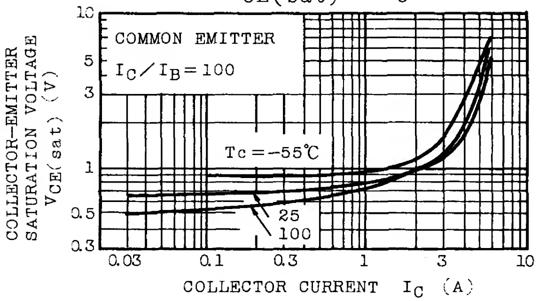
SAFE OPERATING AREA



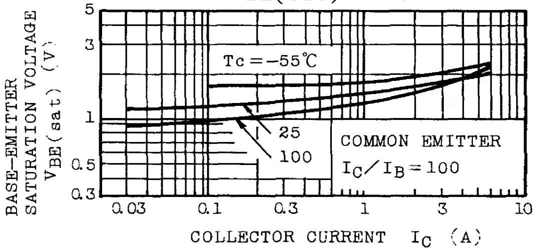
$h_{FE} - I_C$



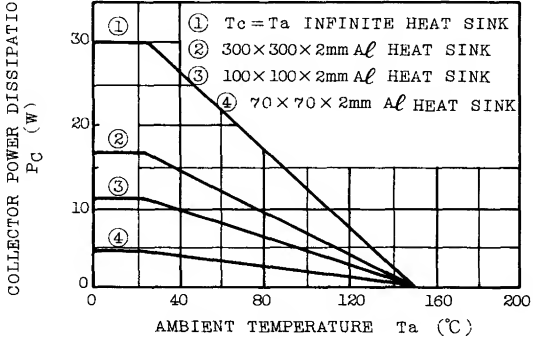
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Ta$



2SD1361

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

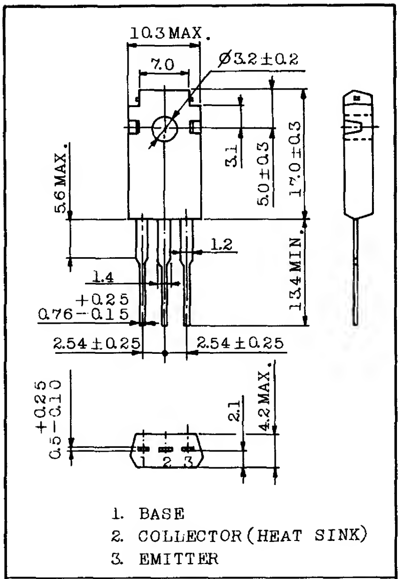
HIGH VOLTAGE SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm

FEATURES:

- High DC Current Gain : h_{FE}=2000(Min.)(V_{CE}=2V, I_C=2A)



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

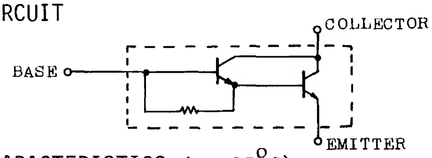
JEDEC	–
EIAJ	–
TOSHIBA	2-10K1A

Weight : 2.0g

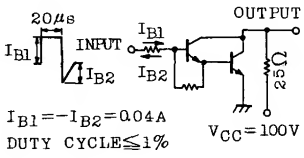
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

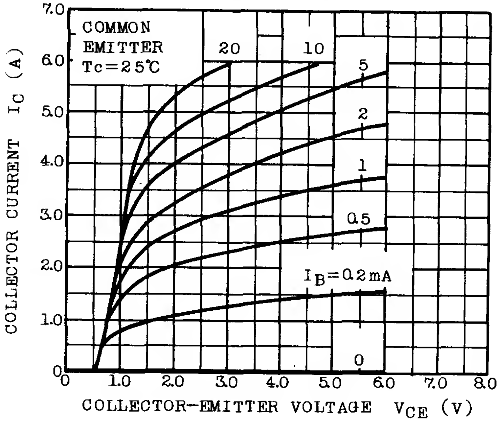
EQUIVALENT CIRCUIT



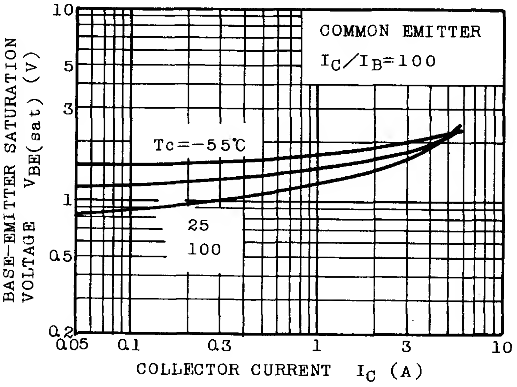
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=300V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	250	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	200	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	
Collector Output Capacitance		Cob	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs OUTPUT I_{B1} INPUT I_{B1} I_{B2} I_{B2} 25Ω I_{B1}=−I_{B2}=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

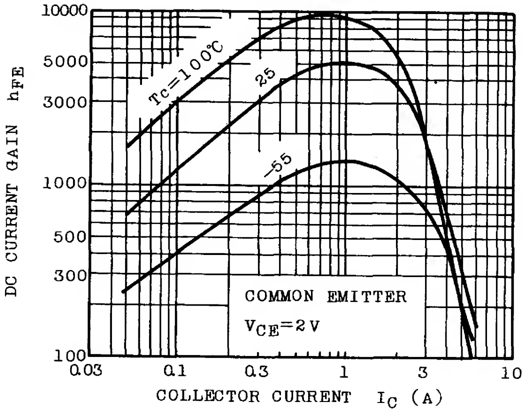
IC – VCE



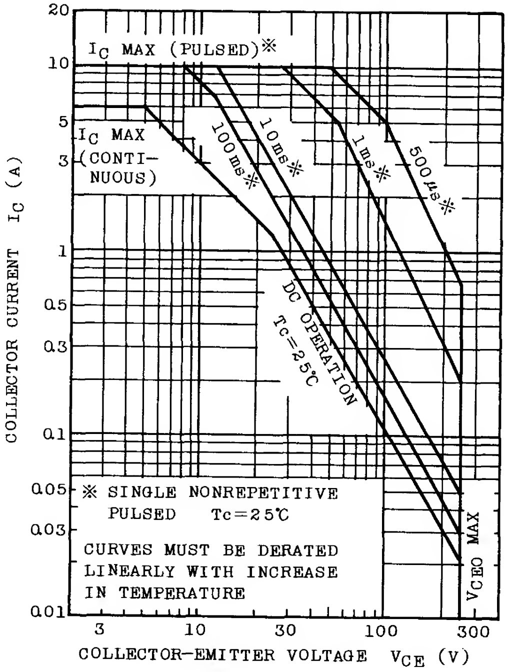
VBE(sat) – IC



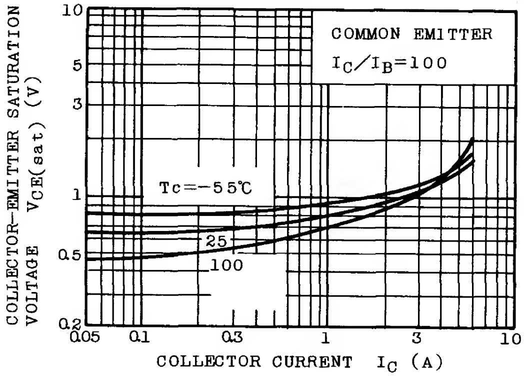
hFE – IC



SAFE OPERATING AREA



VCE(sat) – IC



2SD1362

SILICON NPN TRIPLE DIFFUSED TYPE

HIGH CURRENT SWITCHING APPLICATIONS.

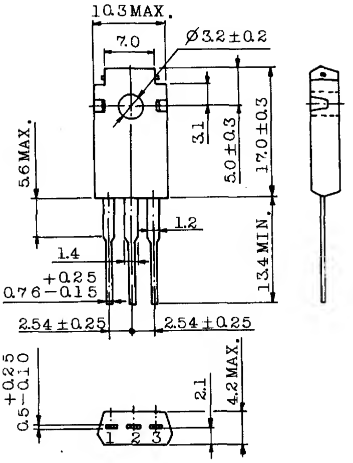
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : I_C=7A
- Low Saturation Voltage : $V_{CE(sat)}$=0.5V(Max.) (at I_C=4A)
- High Collector Power Dissipation : P_C=40W (at Tc=25°C)
- Complementary to 2SB992

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

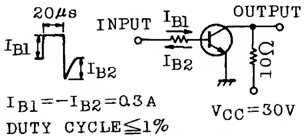
JEDEC	–
EIAJ	–
TOSHIBA	2-10K1A

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

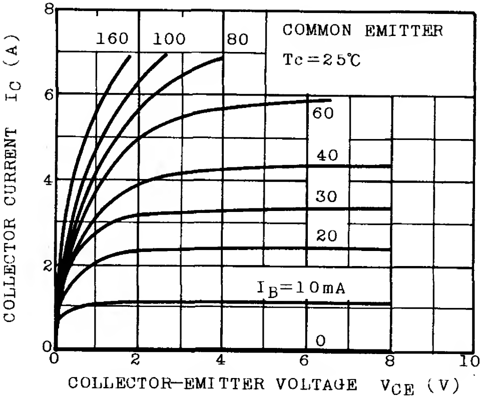
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	–	–	5	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	–	–	5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	–	–	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	–	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=4A	30	–	–	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	–	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.4A	–	0.9	1.4	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	–	10	–	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	–	250	–	pF
Switching Time	Turn-on Time	t_{on}		–	0.4	–	μs
	Storage Time	t_{stg}		–	2.5	–	
	Fall Time	t_f		–	0.5	–	

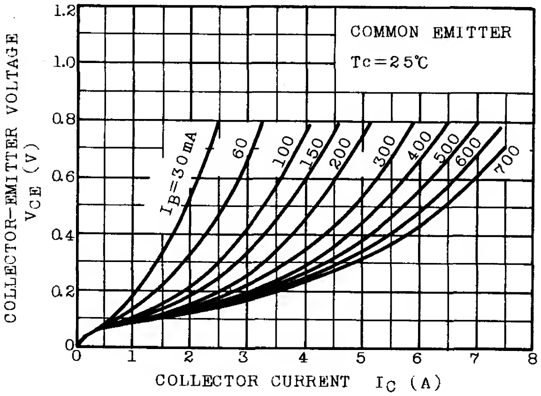
Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

TOSHIBA CORPORATION

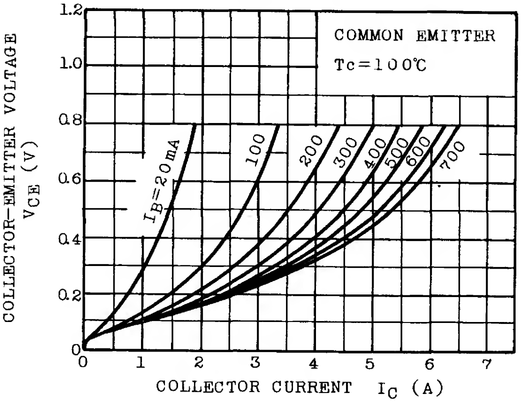
$I_C - V_{CE}$



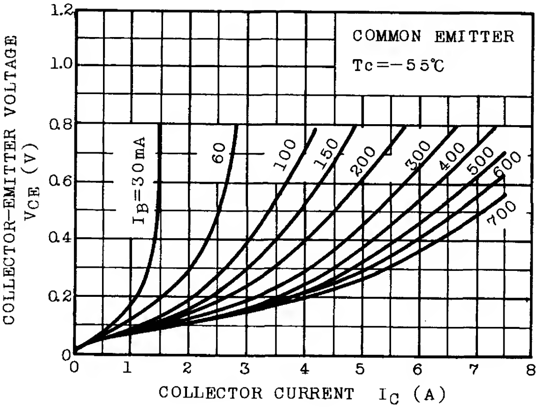
$V_{CE} - I_C$



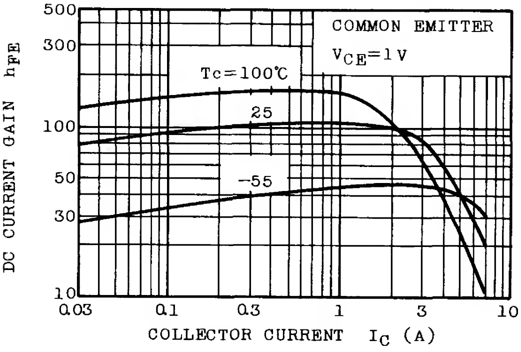
$V_{CE} - I_C$



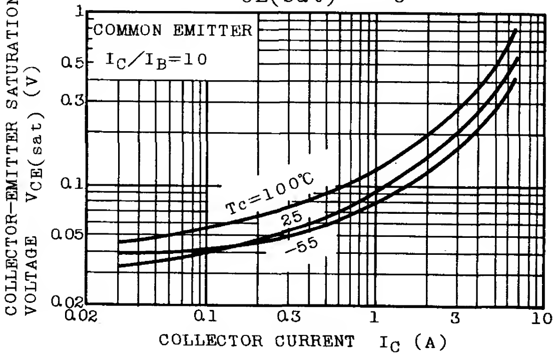
$V_{CE} - I_C$

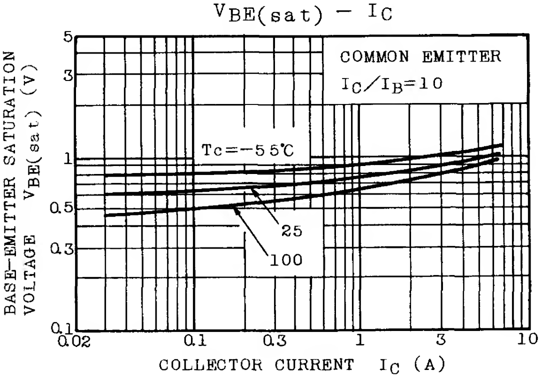


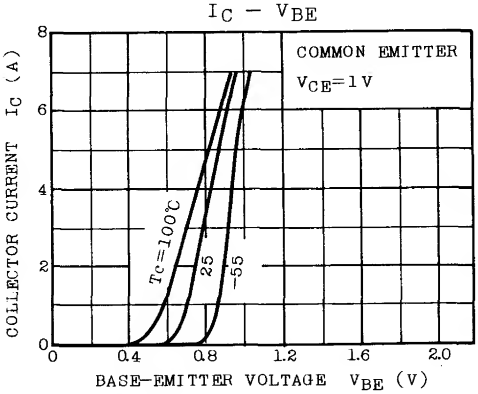
$h_{FE} - I_C$

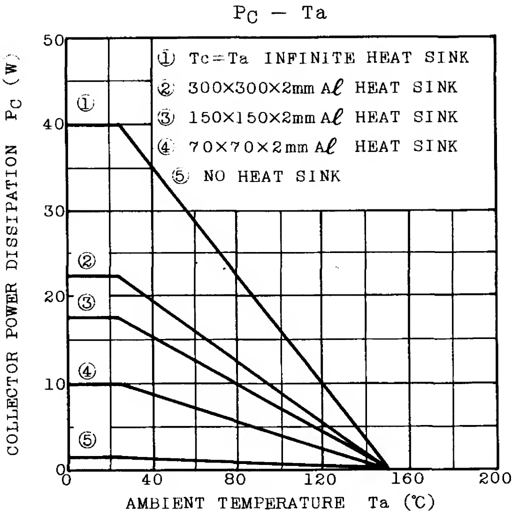


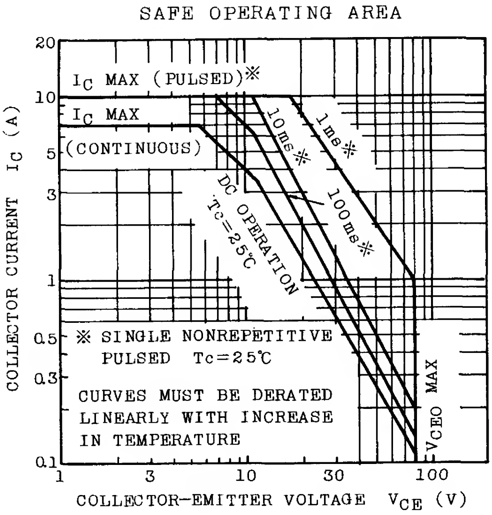
$V_{CE(sat)} - I_C$




VBE(sat) – IC
COMMON EMITTER
IC/IB=10
Tc=−55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
5
3
1
0.5
0.3
0.1
0.02
0.1
0.3
1
3
10
COLLECTOR CURRENT IC (A)


IC – VBE
COMMON EMITTER
VCE=1V
Tc=100℃
25
−55
COLLECTOR CURRENT IC (A)
8
6
4
2
0
0.4
0.8
1.2
1.6
2.0
BASE-EMITTER VOLTAGE VBE (V)


PC – Ta
① Tc=Ta INFINITE HEAT SINK
② 300×300×2mm Al HEAT SINK
③ 150×150×2mm Al HEAT SINK
④ 70×70×2mm Al HEAT SINK
⑤ NO HEAT SINK
①
②
③
④
⑤
COLLECTOR POWER DISSIPATION PC (W)
50
40
30
20
10
0
0
40
80
120
160
200
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX
(CONTINUOUS)
10ms※
1ms※
100ms※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE PULSED Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
COLLECTOR-EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE

2SD1363

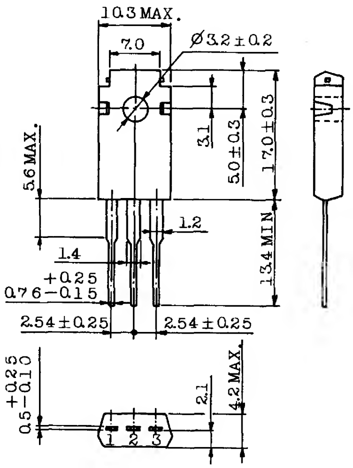
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:
- High Collector Current : I_C=7A
- Low Saturation Voltage
  : $V_{CE(sat)}$=0.4V(Max.) (at I_C=4A)
- High Collector Power Dissipation
  : P_C=40W (at Tc=25°C)
- Complementary to 2SB993

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	70	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

INDUSTRIAL APPLICATIONS
Unit in mm

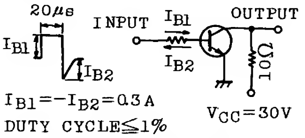


1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10K1A

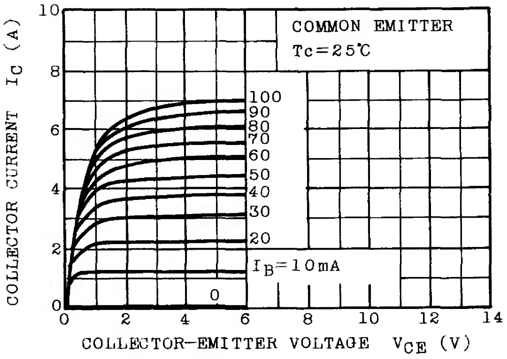
Weight : 2.0g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

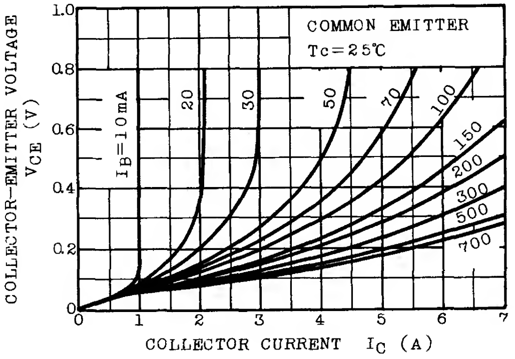
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=70V, I_E=0	-	-	30	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.4A	-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT IB1 OUTPUT IB1 IB2 IB2 10Ω IB1=−IB2=0.3A DUTY CYCLE≦1% VCC=30V	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

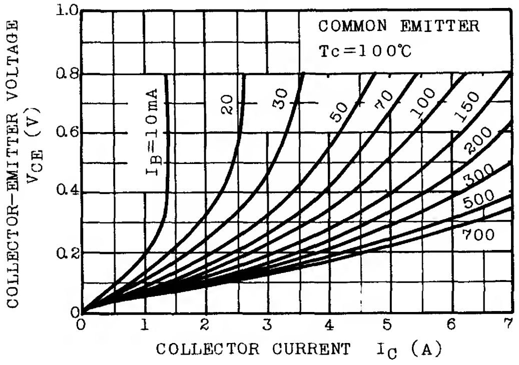
$I_C - V_{CE}$



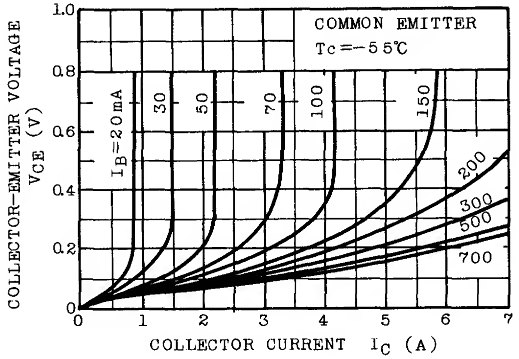
$V_{CE} - I_C$



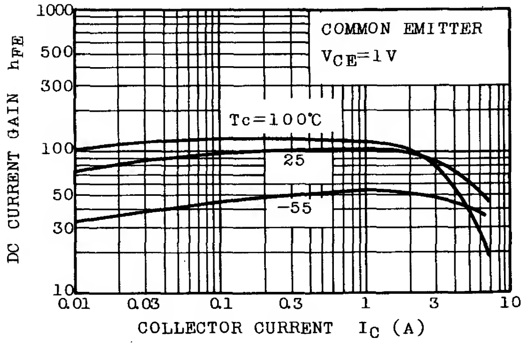
$V_{CE} - I_C$



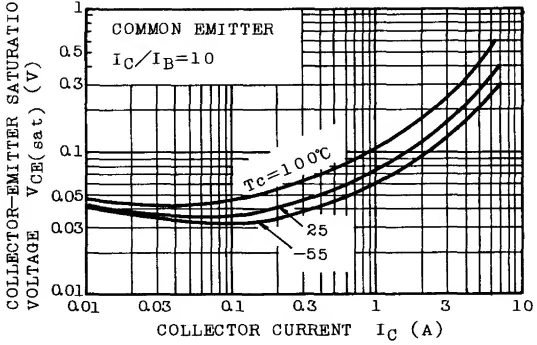
$V_{CE} - I_C$

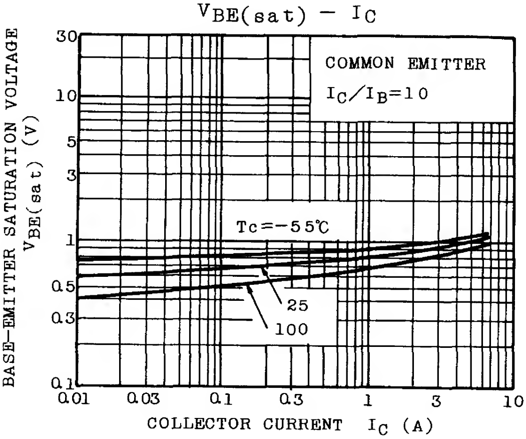


$h_{FE} - I_C$

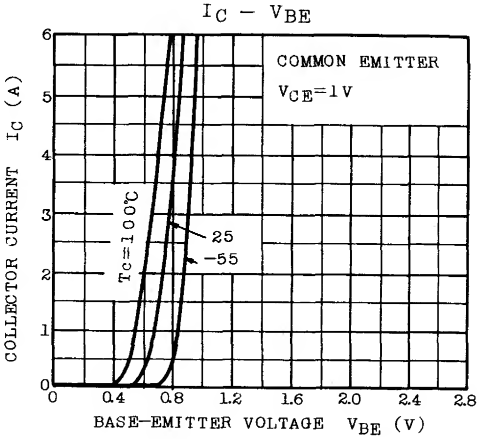


$V_{CE(sat)} - I_C$

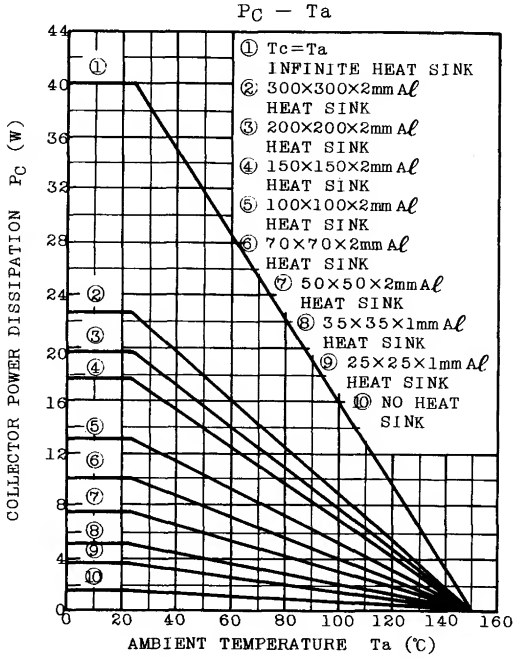




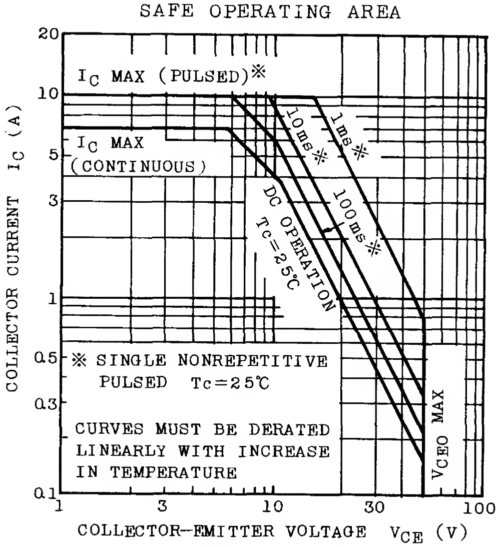
$V_{BE(sat)}$ – I_C



I_C – V_{BE}



P_C – Ta



SAFE OPERATING AREA

2SD1405

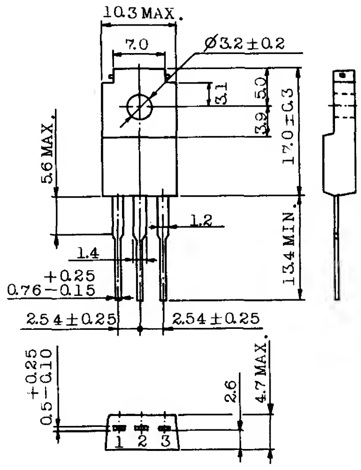
SILICON NPN TRIPLE DIFFUSED TYPE

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain of 200 to 1200 at V_{CE}=5V, I_C=0.5A
- Low $V_{CE(sat)}$ of 1.0V (Max.) at I_C=1A, I_B=0.02A
- Collector Power Dissipation of 25W at Tc=25°C

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

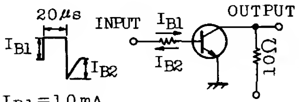
JEDEC	–
EIAJ	–
TOSHIBA	2-10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

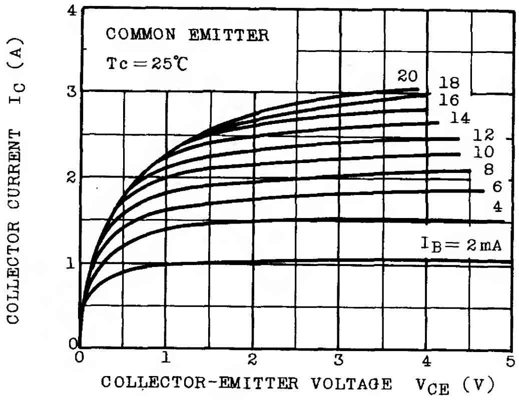
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

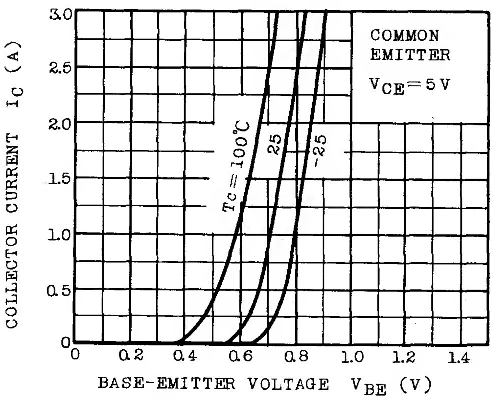
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=50V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		h_{FE} (Note)	V_{CE}=5V, I_C=0.5A	200	-	1200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.02A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	5.0	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 I_{B1}=10mA I_{B2}=−20mA DUTY CYCLE<1% V_{CC}=10V	-	2.0	-	μs
	Storage Time	t_{stg}		-	5.0	-	
	Fall Time	t_f		-	3.0	-	

Note : h_{FE} Classification GR : 200~400, BL : 350~700, V : 600~1200

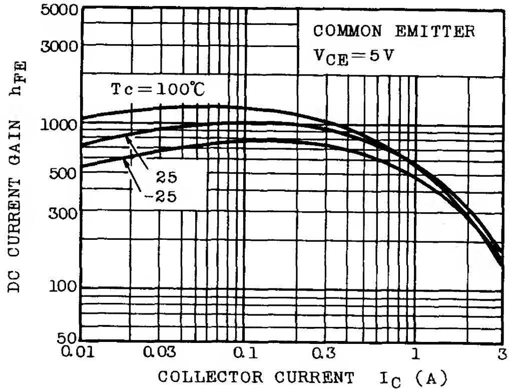
$I_C - V_{CE}$



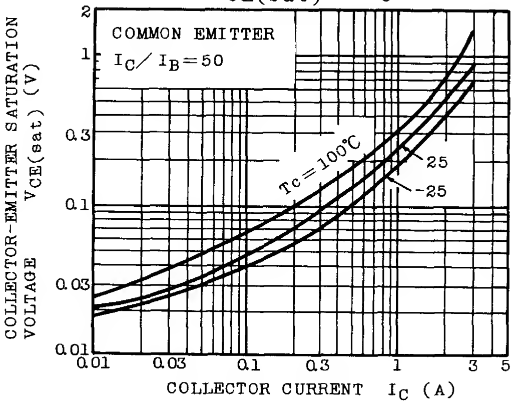
$I_C - V_{BE}$



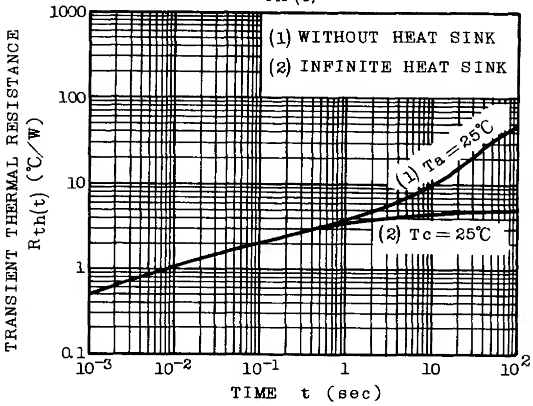
$h_{FE} - I_C$



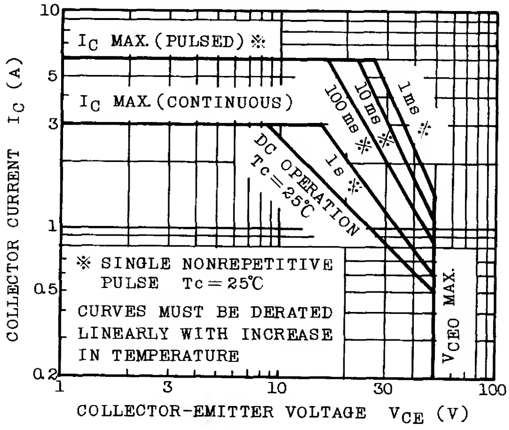
$V_{CE(sat)} - I_C$



$R_{th}(t) - t$



SAFE OPERATING AREA

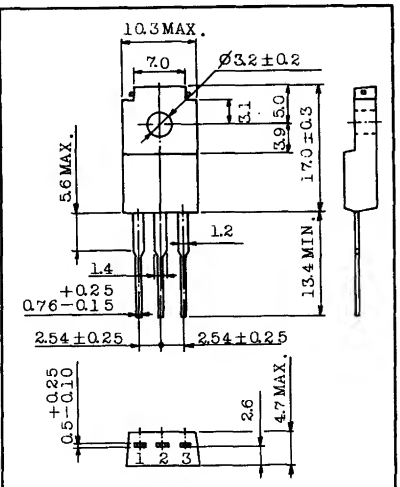


2SD1406

SILICON NPN TRIPLE DIFFUSED TYPE

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

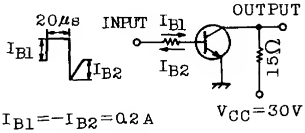
FEATURES:

- High DC Current Gain : h_{FE}=300(Max.)(V_{CE}=5V, I_C=0.5A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.0V(Max.)(I_C=3A, I_B=0.3A)
- High Power Dissipation : P_C=25W (Tc=25°C)
- Complementary to 2SB1015

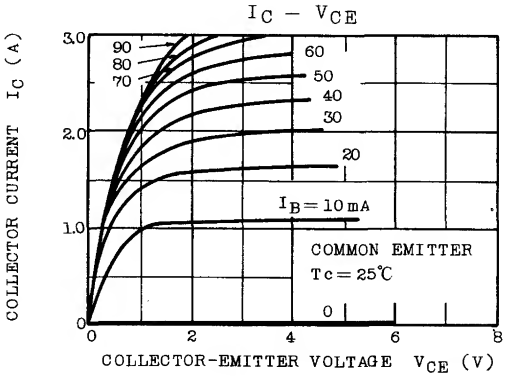
MAXIMUM RATINGS (Ta=25°C)

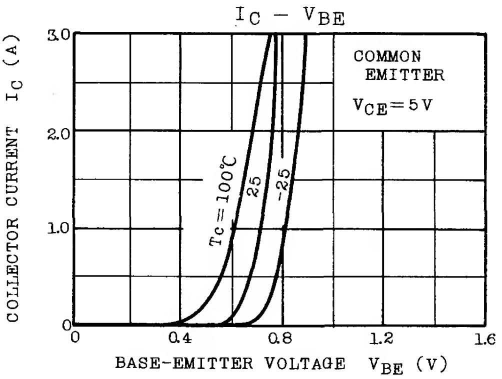
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		25	
Junction Temperature		Tj	150	°C
Storage Temperature Range		Tstg	-55～150	°C

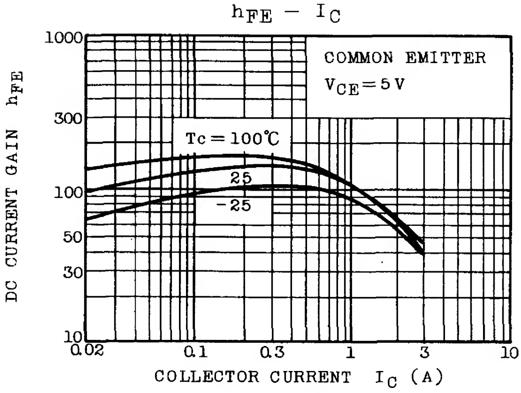
ELECTRICAL CHARACTERISTICS (Ta=25°C)

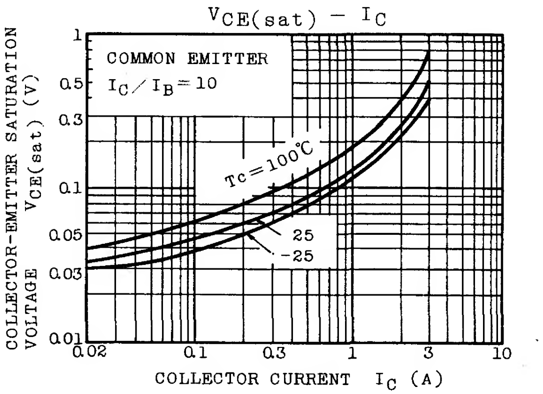
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	60	-	-	V
DC Current Gain		h_{FE}(Note)	V_{CE}=5V, I_C=0.5A	60	-	300	-
Collector Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	V_{CE}=5V, I_C=0.5A	-	0.7	1.0	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.5A	-	3.0	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 15Ω V_{CC}=30V I_{B1}=−I_{B2}=0.2A DUTY CYCLE<1%	-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

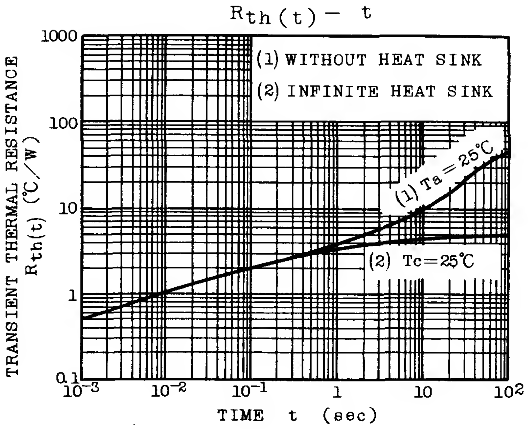
Note : h_{FE} Classification O : 60～120, Y : 100～200, GR : 150～300

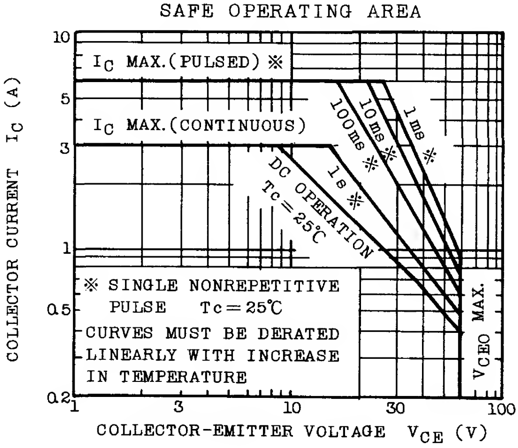

IC – VCE
COLLECTOR CURRENT IC (A)
3.0
2.0
1.0
0
90
80
70
60
50
40
30
20
IB = 10 mA
0
COMMON EMITTER
Tc = 25℃
0 2 4 6 8
COLLECTOR-EMITTER VOLTAGE VCE (V)


IC – VBE
COLLECTOR CURRENT IC (A)
3.0
2.0
1.0
0
COMMON EMITTER
VCE = 5 V
Tc = 100℃
25
−25
0 0.4 0.8 1.2 1.6
BASE-EMITTER VOLTAGE VBE (V)


hFE – IC
DC CURRENT GAIN hFE
1000
300
100
50
30
10
COMMON EMITTER
VCE = 5 V
Tc = 100℃
25
−25
0.02 0.1 0.3 1 3 10
COLLECTOR CURRENT IC (A)


VCE(sat) – IC
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
1
0.5
0.3
0.1
0.05
0.03
0.01
COMMON EMITTER
IC / IB = 10
Tc = 100℃
25
−25
0.02 0.1 0.3 1 3 10
COLLECTOR CURRENT IC (A)


Rth(t) – t
TRANSIENT THERMAL RESISTANCE Rth(t) (℃/W)
1000
100
10
1
0.1
(1) WITHOUT HEAT SINK
(2) INFINITE HEAT SINK
(1) Ta = 25℃
(2) Tc = 25℃
10⁻³ 10⁻² 10⁻¹ 1 10 10²
TIME t (sec)


SAFE OPERATING AREA
COLLECTOR CURRENT IC (A)
10
5
3
1
0.5
0.2
IC MAX. (PULSED) ※
IC MAX. (CONTINUOUS)
1ms ※
10ms ※
100ms ※
1s ※
DC OPERATION
Tc = 25℃
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
VCEO MAX.
1 3 10 30 100
COLLECTOR-EMITTER VOLTAGE VCE (V)

2SD1407

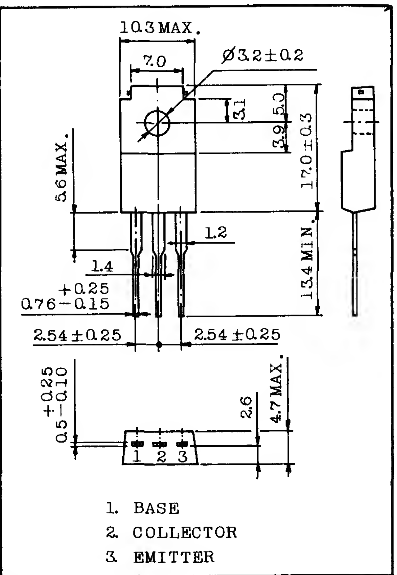
SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : V_{CEO}=100V
- Low Collector Saturation Voltage : $V_{CE(sat)}$=2.0V(Max.)
- Complementary to 2SB1016
- Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

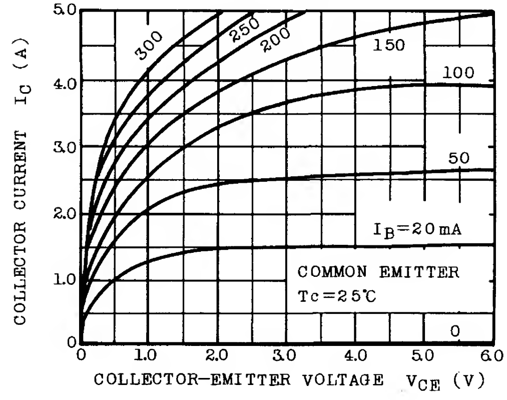
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	0.5	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

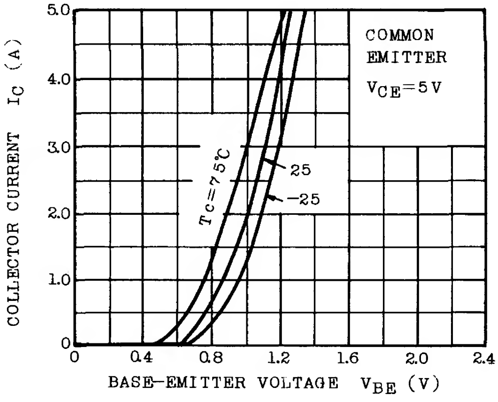
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=1A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=4A	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=1A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=1A	-	12	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240

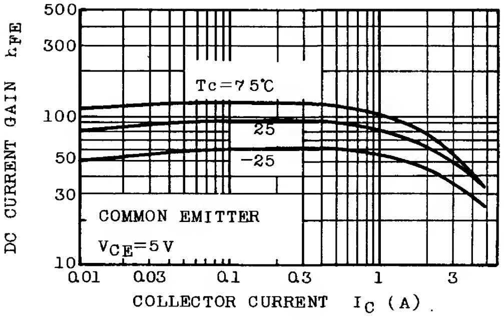
I_C – V_{CE}



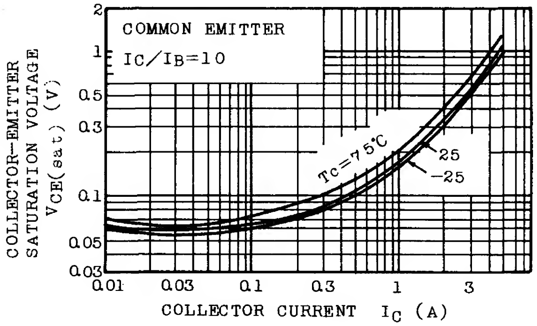
I_C – V_{BE}



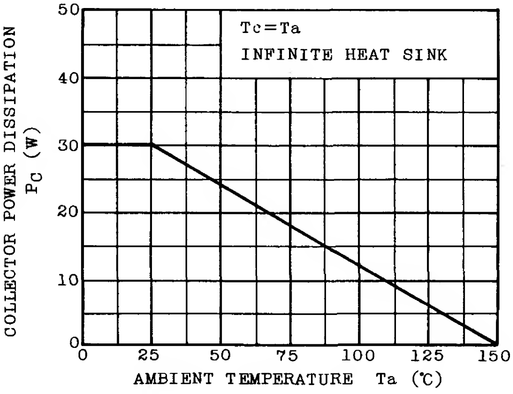
h_{FE} – I_C



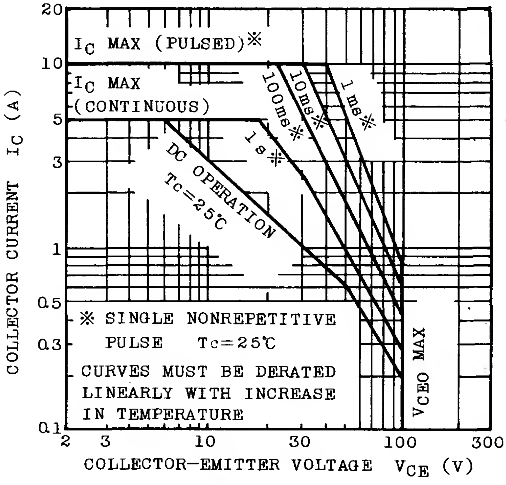
$V_{CE(sat)}$ – I_C



P_C – Ta



SAFE OPERATING AREA

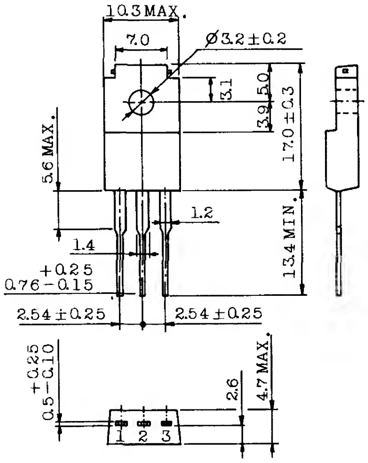


2SD1408

SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER APPLICATIONS.

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-10L1A

Weight : 2.1g

FEATURES:

- High Power Dissipation : P_C=25W (Tc=25°C)
- Good Linearity of h_{FE}
- Complementary to 2SB1017
- Recommended for 20～25W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

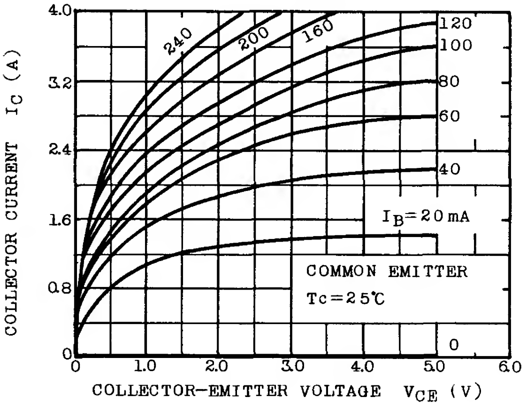
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Base Current	I_B	0.4	A
Collector Power Dissipation (Tc=25°C)	P_C	25	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

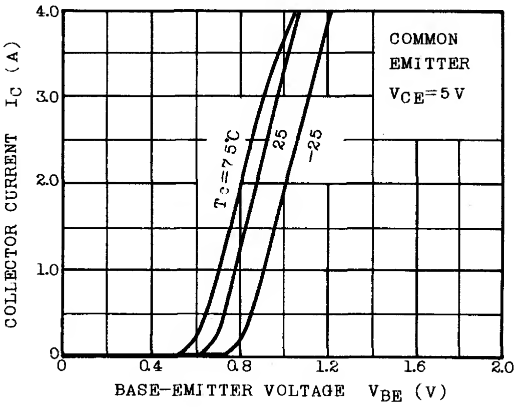
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=80V, I_E=0	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=10mA, I_C=0	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	V_{CE}=5V, I_C=0.5A	40	-	240	
	$h_{FE(2)}$	V_{CE}=5V, I_C=3A	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=3A	-	1.0	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	-	8.0	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40～80, O : 70～140, Y : 120～240

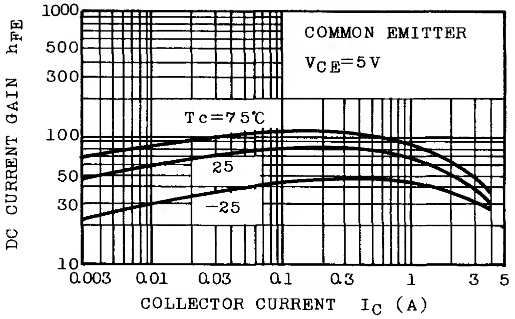
I_C — V_{CE}



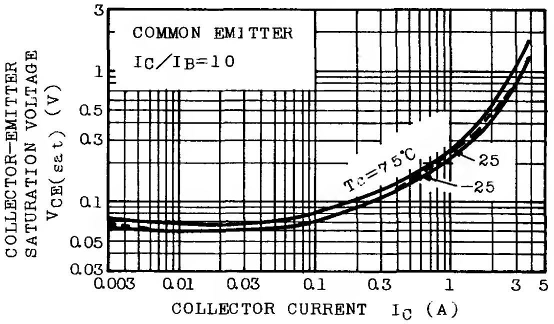
I_C — V_{BE}



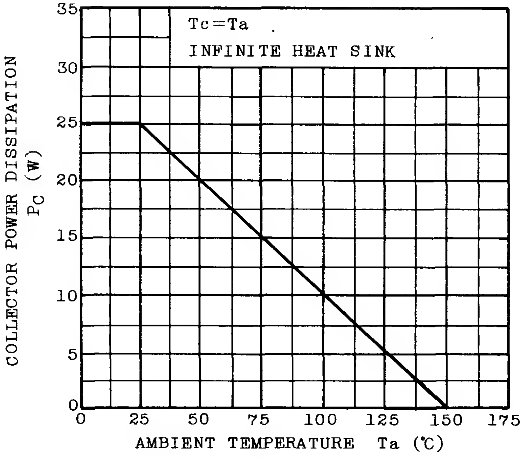
h_{FE} — I_C



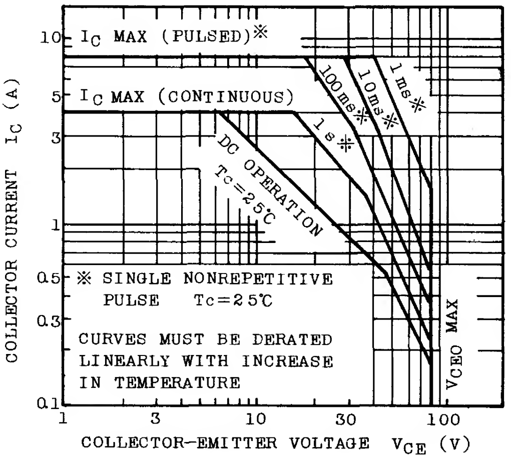
$V_{CE(sat)}$ — I_C



P_C — Ta



SAFE OPERATING AREA



2SD1409

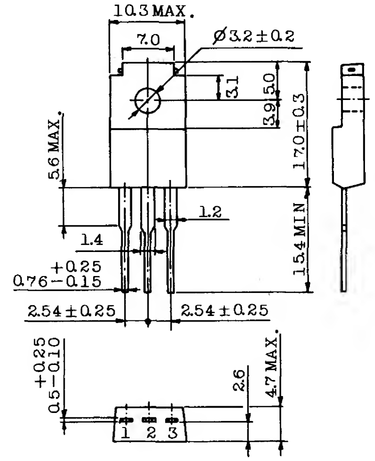
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

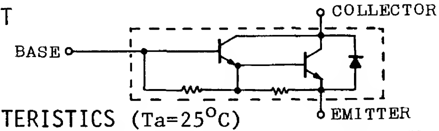
FEATURES:

- High DC Current Gain : h_{FE}=600(Min.) (V_{CE}=2V, I_C=2A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

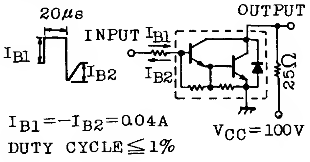
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	6	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−55~150	°C

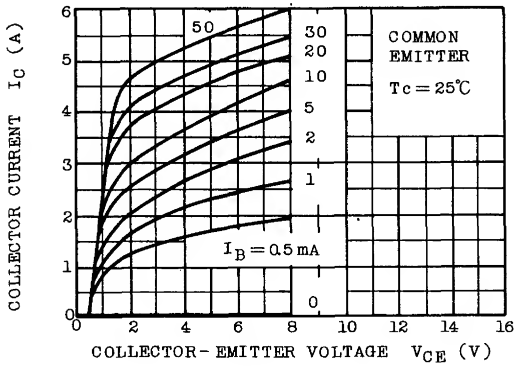
EQUIVALENT CIRCUIT



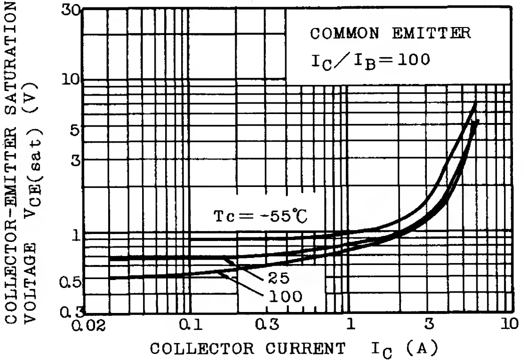
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	600	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=4A, I_B=0	-	-	3.0	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT I_{B1} I_{B2} 25Ω I_{B1}=−I_{B2}=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

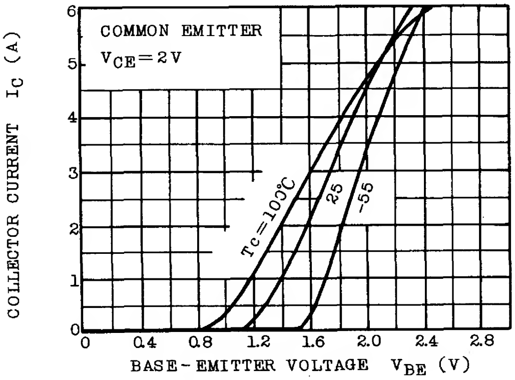
$I_C - V_{CE}$



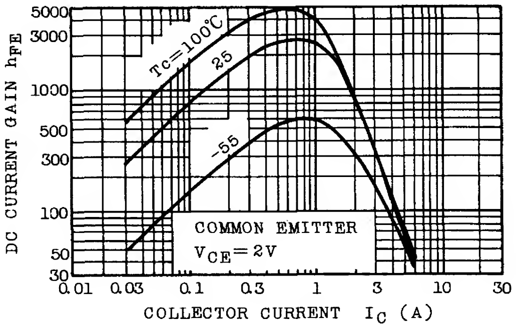
$V_{CE(sat)} - I_C$



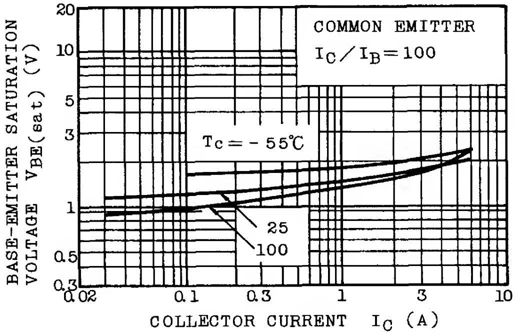
$I_C - V_{BE}$



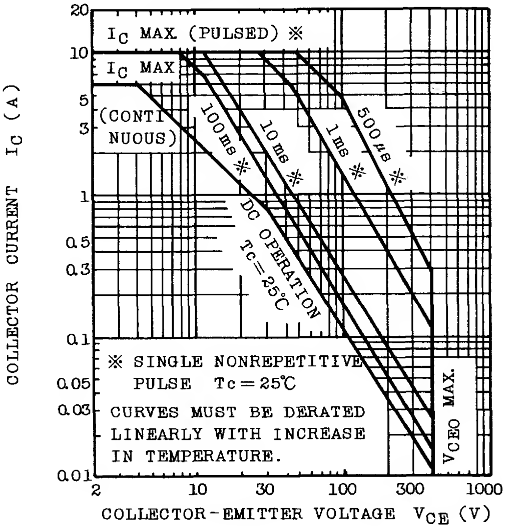
$h_{FE} - I_C$



$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



2SD1410

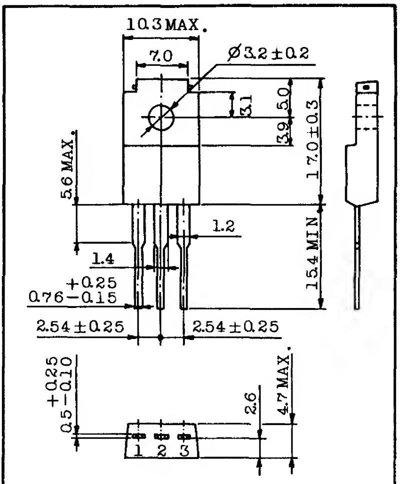
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2−10L1A

Weight : 2.1g

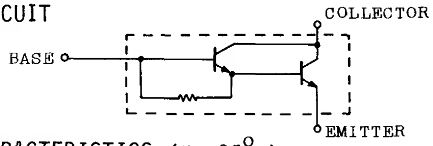
FEATURES:

- High DC Current Gain : h_{FE}=2000(Min.) (V_{CE}=2V, I_C=2A)

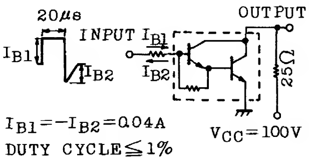
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	250	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	6	A
Base Current		I_B	1	A
Collector Power Dissipation	T_a=25°C	P_C	2.0	W
	T_c=25°C		25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

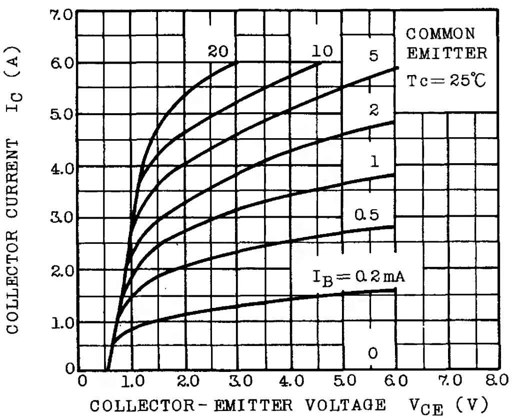
EQUIVALENT CIRCUIT



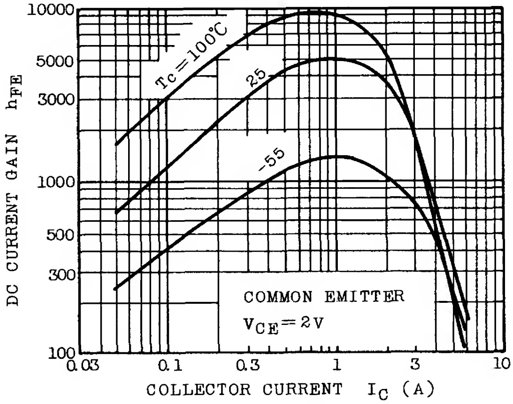
ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=300V, I_E=0	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	250	-	-	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=2A	2000	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=4A	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4A, I_B=0.04A	-	-	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 25Ω I_{B1}=−I_{B2}=0.04A DUTY CYCLE≦1% V_{CC}=100V	-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

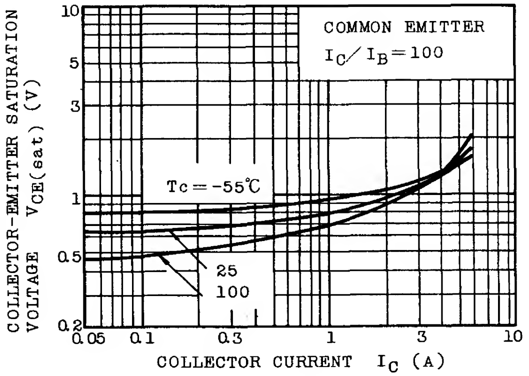
$I_C - V_{CE}$



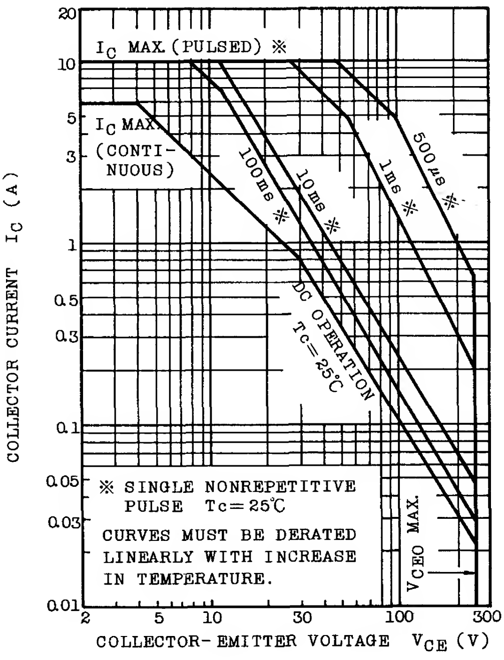
$h_{FE} - I_C$



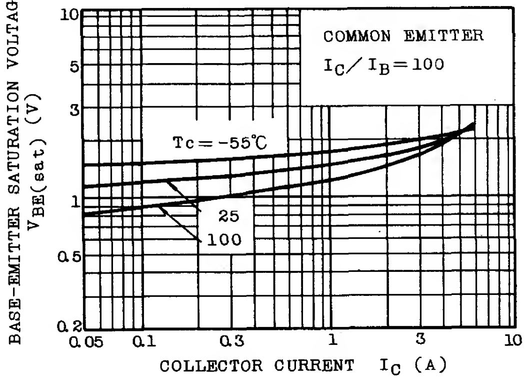
$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



$V_{BE(sat)} - I_C$



2SD1411

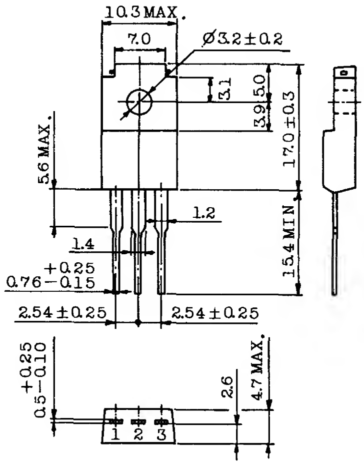
SILICON NPN TRIPLE DIFFUSED TYPE

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
  : $V_{CE(sat)}=0.5V$(Max.) at $I_C=4A$
- Complementary to 2SB1018

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

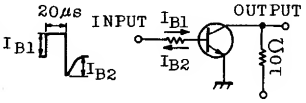
JEDEC	–
EIAJ	–
TOSHIBA	2–10L1A

Weight : 2.1g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

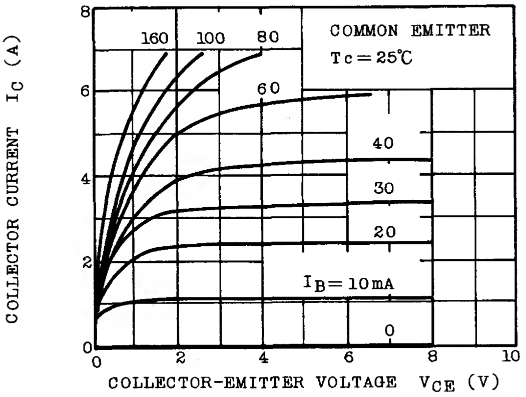
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	2.0	W
	$Tc=25^{\circ}C$		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

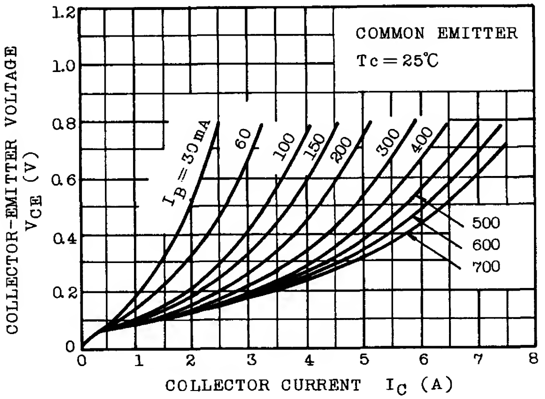
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V,\ I_E=0$	–	–	5	µA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V,\ I_C=0$	–	–	5	µA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA,\ I_B=0$	80	–	–	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V,\ I_C=1A$	70	–	240	
		$h_{FE(2)}$	$V_{CE}=1V,\ I_C=4A$	30	–	–	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A,\ I_B=0.4A$	–	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A,\ I_B=0.4A$	–	0.9	1.4	
Transition Frequency		f_T	$V_{CE}=4V,\ I_C=1A$	–	10	–	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V,\ I_E=0,\ f=1MHz$	–	250	–	pF
Switching Time	Turn-on Time	t_{on}	 20µs INPUT IB1 IB1 IB2 IB2 OUTPUT 10Ω VCC=30V $I_{B1}=-I_{B2}=0.3A$ DUTY CYCLE≦1%	–	0.4	–	µs
	Storage Time	t_{stg}		–	2.5	–	
	Fall Time	t_f		–	0.5	–	

Note : $h_{FE(1)}$ Classification O : 70～140, Y : 120～240

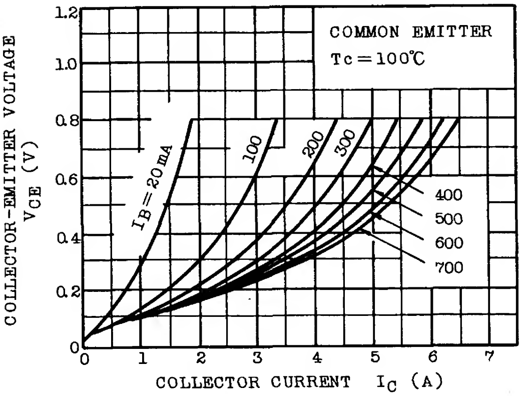
$I_C - V_{CE}$



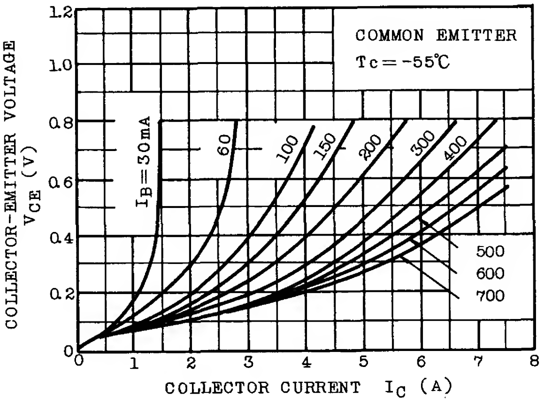
$V_{CE} - I_C$



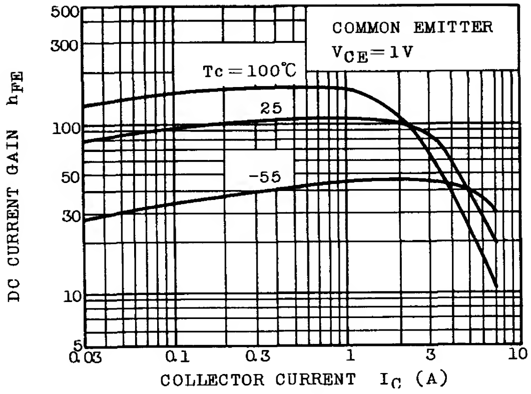
$V_{CE} - I_C$



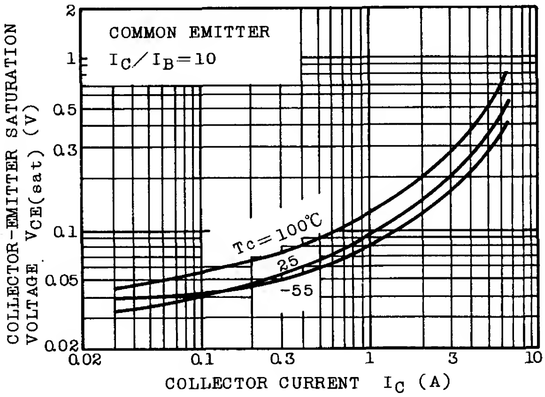
$V_{CE} - I_C$

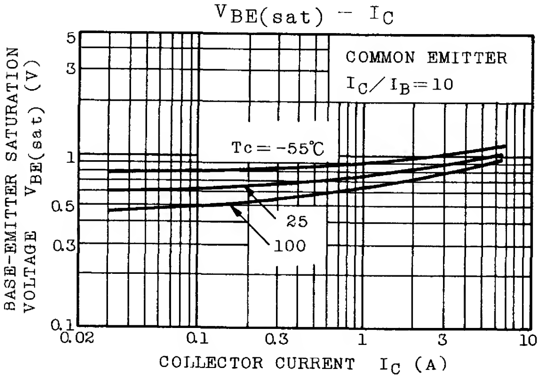


$h_{FE} - I_C$

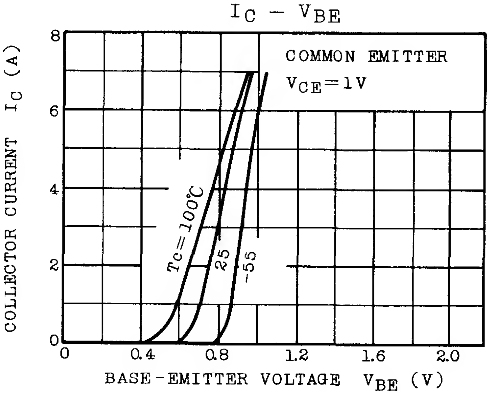


$V_{CE(sat)} - I_C$

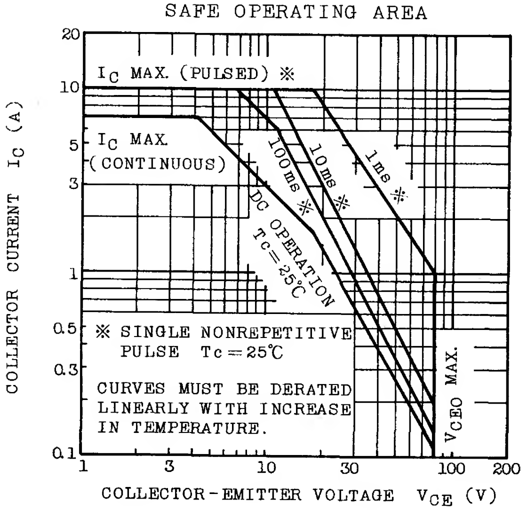




$V_{BE(sat)}$ – I_C
COMMON EMITTER
$I_C/I_B=10$
Tc = -55℃
25
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
5
3
1
0.5
0.3
0.1
0.02
0.1
0.3
1
3
10
COLLECTOR CURRENT I_C (A)



I_C – V_{BE}
COMMON EMITTER
$V_{CE}=1V$
Tc=100℃
25
-55
COLLECTOR CURRENT I_C (A)
8
6
4
2
0
0
0.4
0.8
1.2
1.6
2.0
BASE-EMITTER VOLTAGE V_{BE} (V)



SAFE OPERATING AREA
I_C MAX. (PULSED) ※
I_C MAX. (CONTINUOUS)
100ms ※
10ms ※
1ms ※
DC OPERATION Tc=25℃
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.
V_{CEO} MAX.
COLLECTOR CURRENT I_C (A)
20
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
200
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED TYPE

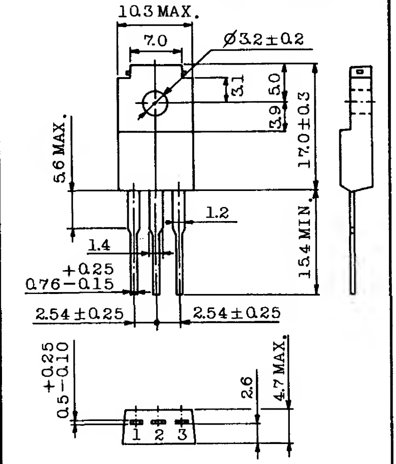
2SD1412

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage : $V_{CE(sat)}$=0.4V(Max.) at I_C=4A
- Complementary to 2SB1019

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

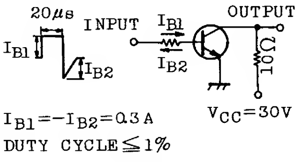
JEDEC	−
EIAJ	−
TOSHIBA	2−10L1A

Weight : 2.1g

MAXIMUM RATINGS (Ta=25°C)

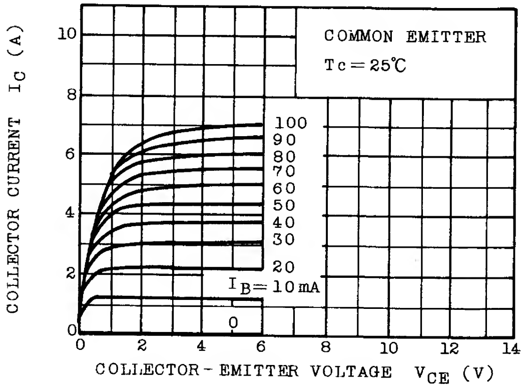
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	70	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		30	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTIC (Ta=25°C)

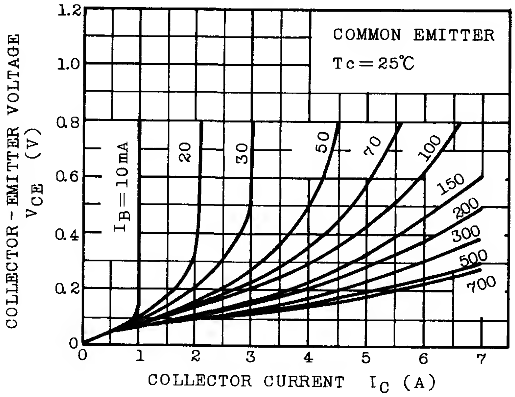
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=70V, I_E=0	-	-	30	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	V_{CE}=1V, I_C=1A	70	-	240	
		$h_{FE(2)}$	V_{CE}=1V, I_C=4A	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	I_C=4A, I_B=0.4A	-	0.9	1.2	
Transition Frequency		f_T	V_{CE}=4V, I_C=1A	-	10	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT OUTPUT I_{B1} I_{B2} 10Ω V_{CC}=30V I_{B1}=−I_{B2}=0.3A DUTY CYCLE≦1%	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

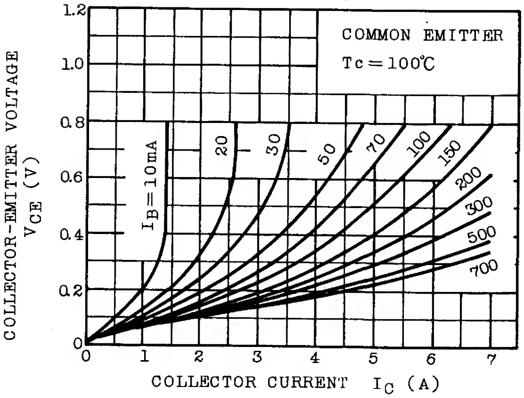
$I_C - V_{CE}$



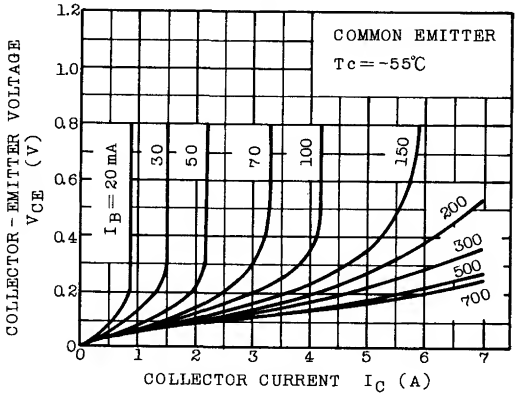
$V_{CE} - I_C$



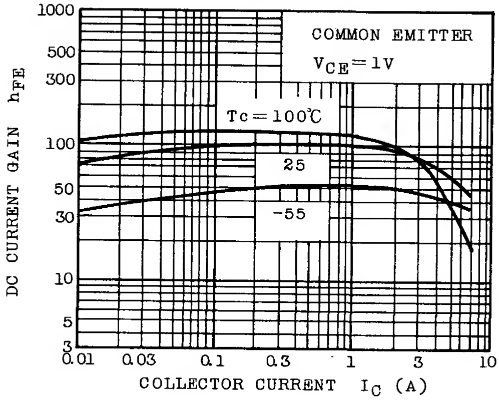
$V_{CE} - I_C$



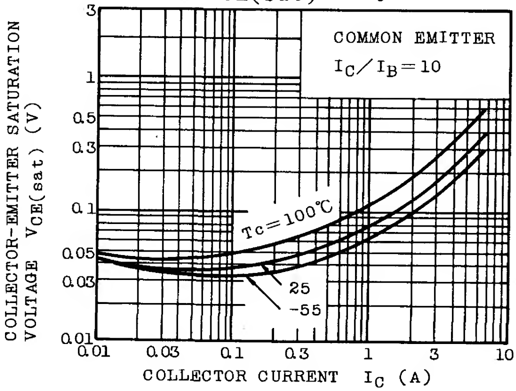
$V_{CE} - I_C$

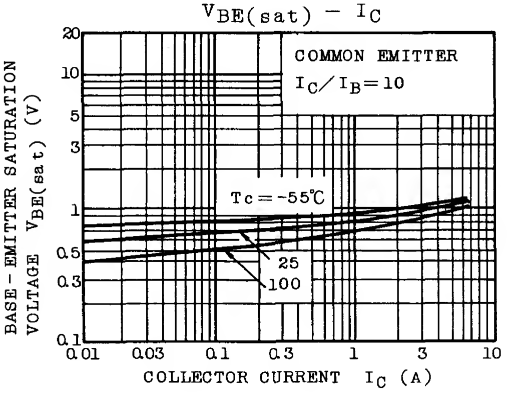


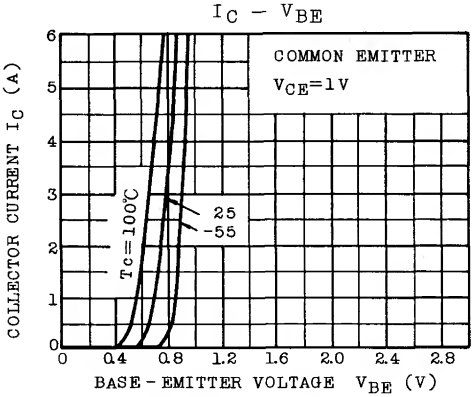
$h_{FE} - I_C$

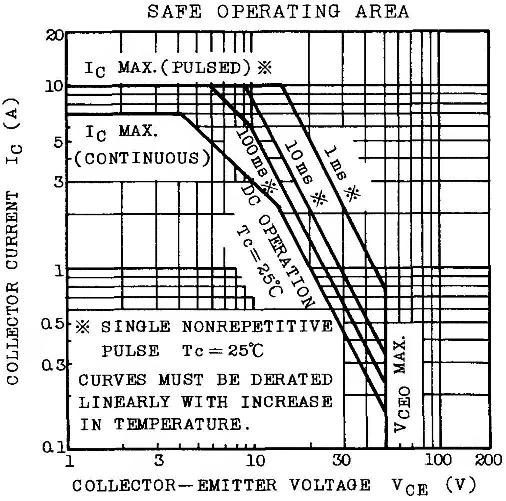


$V_{CE(sat)} - I_C$




VBE(sat) – IC
COMMON EMITTER
IC/IB=10
Tc=-55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.01
0.03
0.1
0.3
1
3
10


IC – VBE
COMMON EMITTER
VCE=1V
Tc=100℃
25
-55
COLLECTOR CURRENT IC (A)
BASE-EMITTER VOLTAGE VBE (V)
0
1
2
3
4
5
6
0.4
0.8
1.2
1.6
2.0
2.4
2.8


SAFE OPERATING AREA
IC MAX.(PULSED)※
IC MAX.
(CONTINUOUS)
100ms※
10ms※
1ms※
DC OPERATION
Tc=25℃
※ SINGLE NONREPETITIVE
PULSE Tc=25℃
CURVES MUST BE DERATED
LINEARLY WITH INCREASE
IN TEMPERATURE.
VCEO MAX.
COLLECTOR CURRENT IC (A)
COLLECTOR–EMITTER VOLTAGE VCE (V)
20
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
200

2SD1425

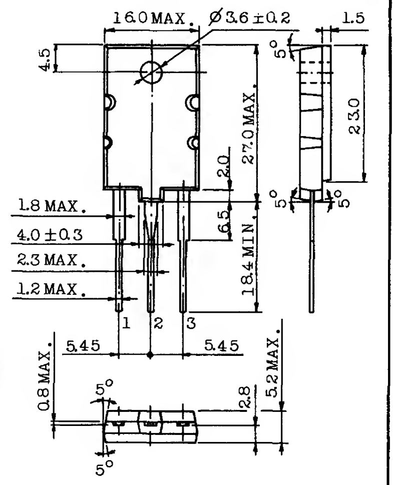
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V(Typ.) (I_C=2A, I_B=0.6A)
- High Speed : t_f=1.0μs(Max.) (I_{CP}=2A, $I_{B1(end)}$=0.6A)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

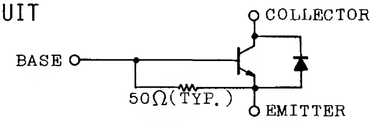
JEDEC	—
EIAJ	—
TOSHIBA	2-16D1A

Weight : 5.2g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

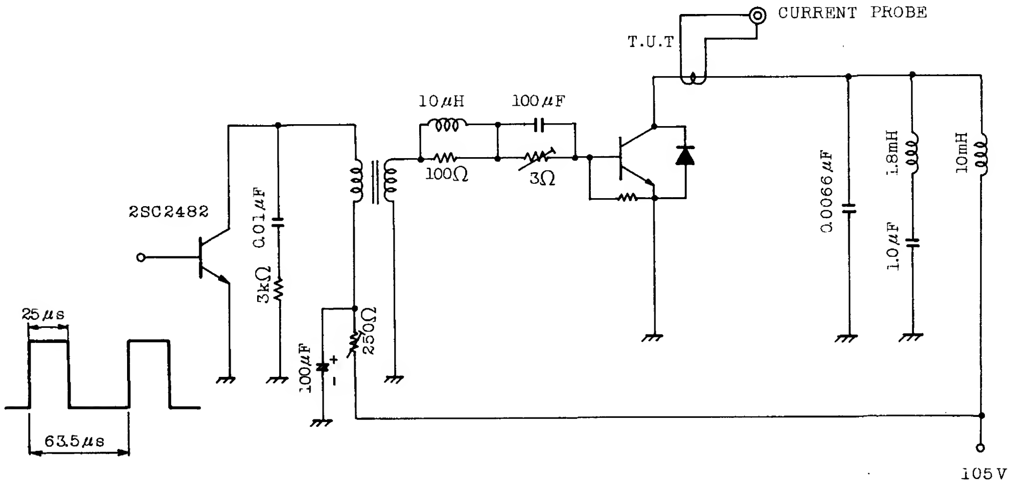
EQUIVALENT CIRCUIT



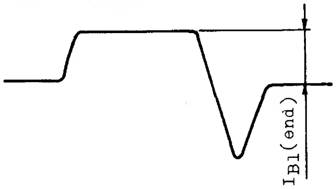
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=0.6A	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2A, I_B=0.6A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=2.5A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time (Fig.)	t_f	I_{CP}=2A, $I_{B1(end)}$=0.6A	-	0.5	1.0	μs

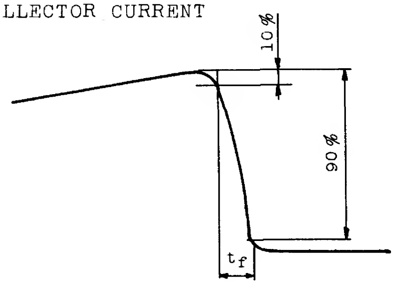
Fig. t_f TEST CIRCUIT



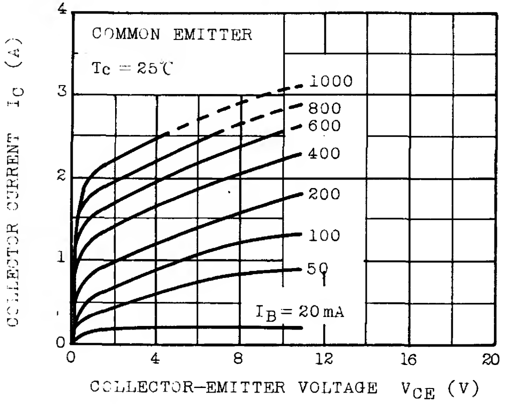
BASE CURRENT



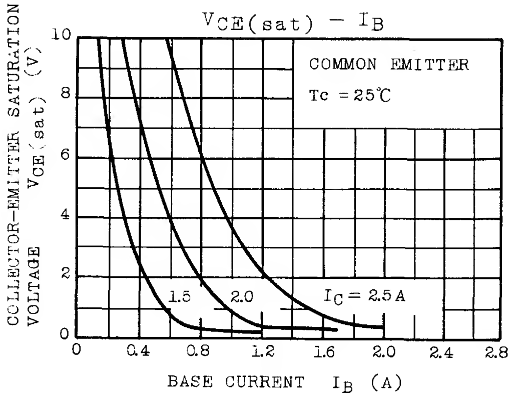
COLLECTOR CURRENT



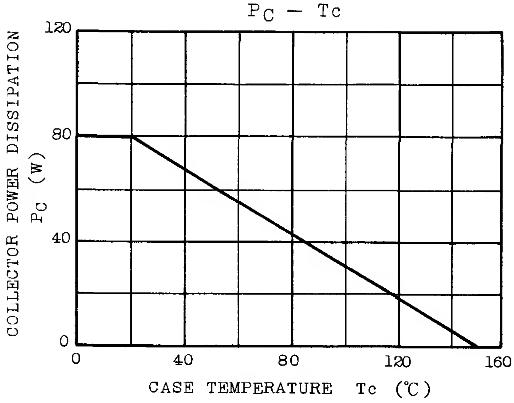
$V_{CE} - I_C$



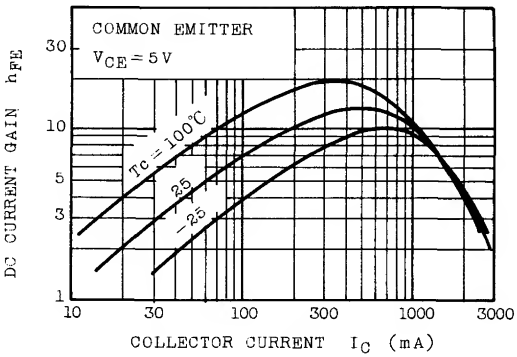
$V_{CE(sat)} - I_B$



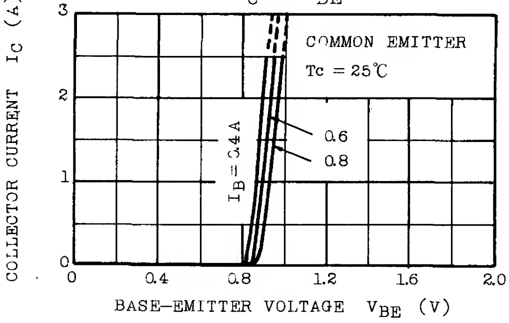
$P_C - T_c$



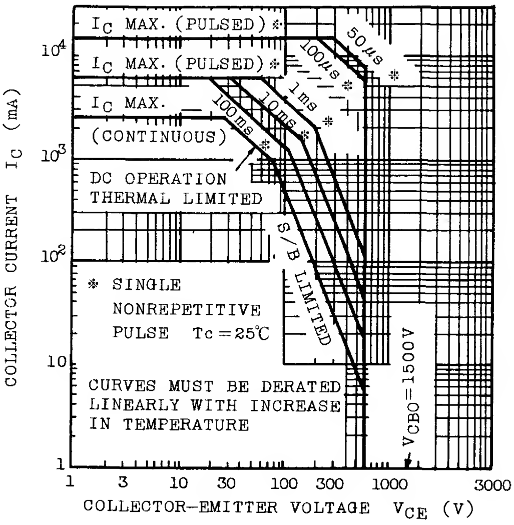
$h_{FE} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA

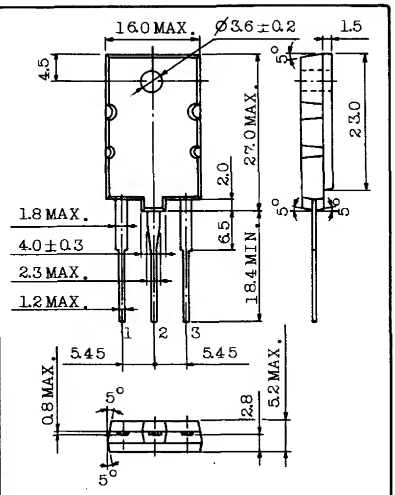


SILICON NPN TRIPLE DIFFUSED MESA TYPE

2SD1426

Unit in mm

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-16D1A

Weight : 5.2g

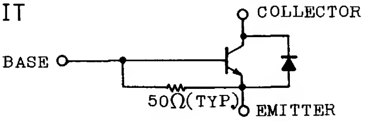
FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V(Typ.) (I_C=3A, I_B=0.8A)
- High Speed : t_f=1.0μs(Max.) (I_{CP}=3A, $I_{B1(end)}$=0.8A)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

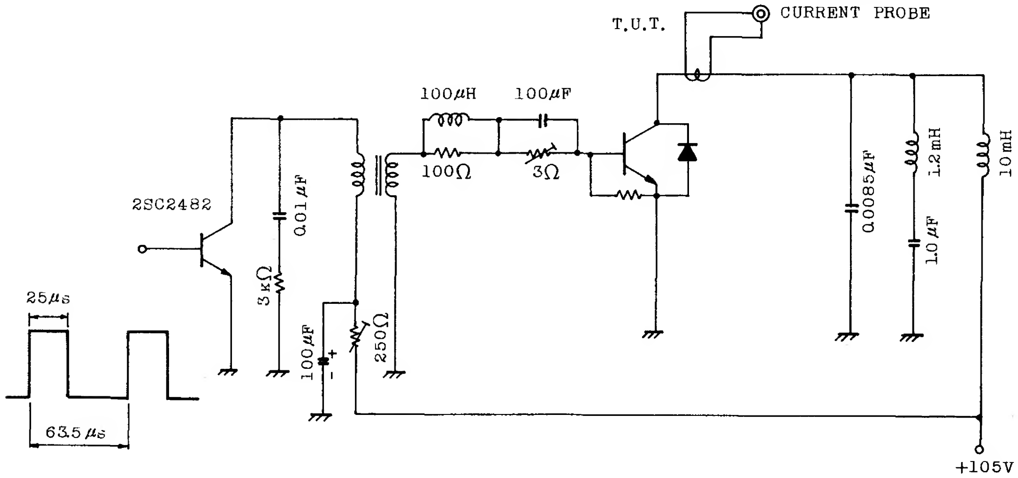
EQUIVALENT CIRCUIT

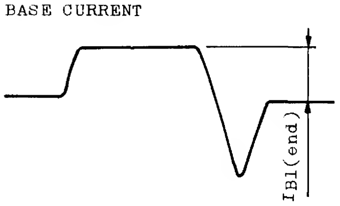


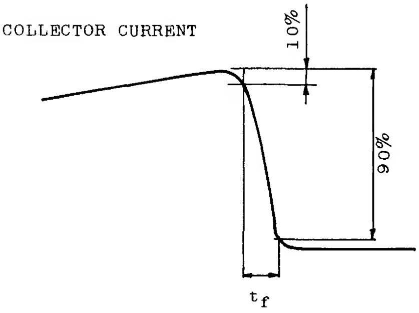
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.8A	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=3A, I_B=0.8A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=3.5A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time (Fig.)	t_f	I_{CP}=3A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

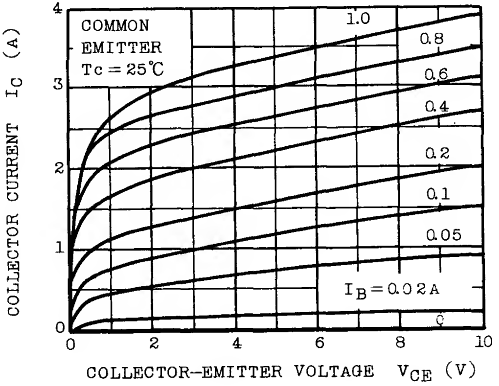
Fig. t_f TEST CIRCUIT



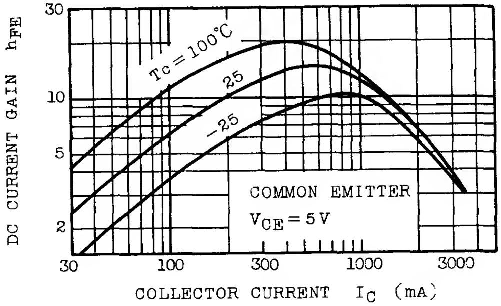




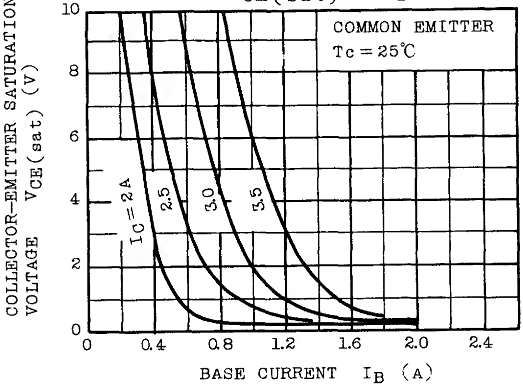
I_C – V_{CE}



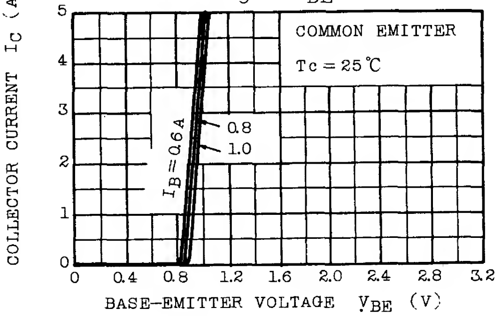
h_{FE} – I_C



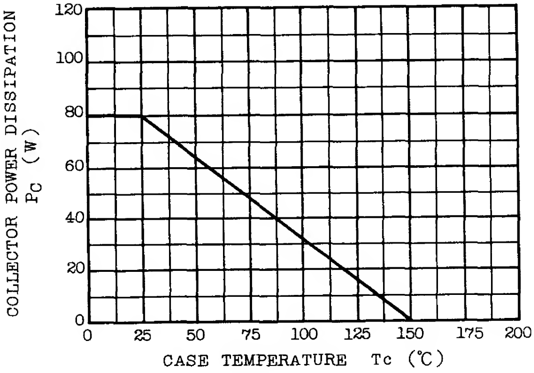
$V_{CE(sat)}$ – I_B



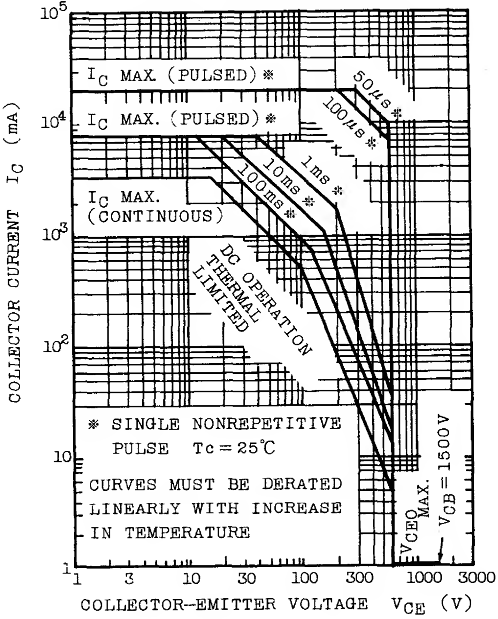
I_C – V_{BE}



P_C – Tc



SAFE OPERATING AREA



2SD1427

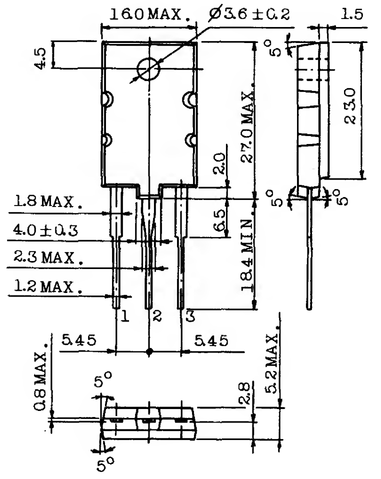
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V(Max.) (I_C=4A, I_B=0.8A)
- High Speed : t_f=1.0μs(Max.)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

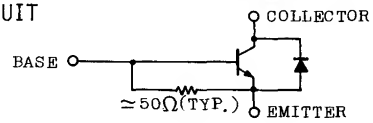
JEDEC	―
EIAJ	―
TOSHIBA	2-16D1A

Weight : 5.2g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

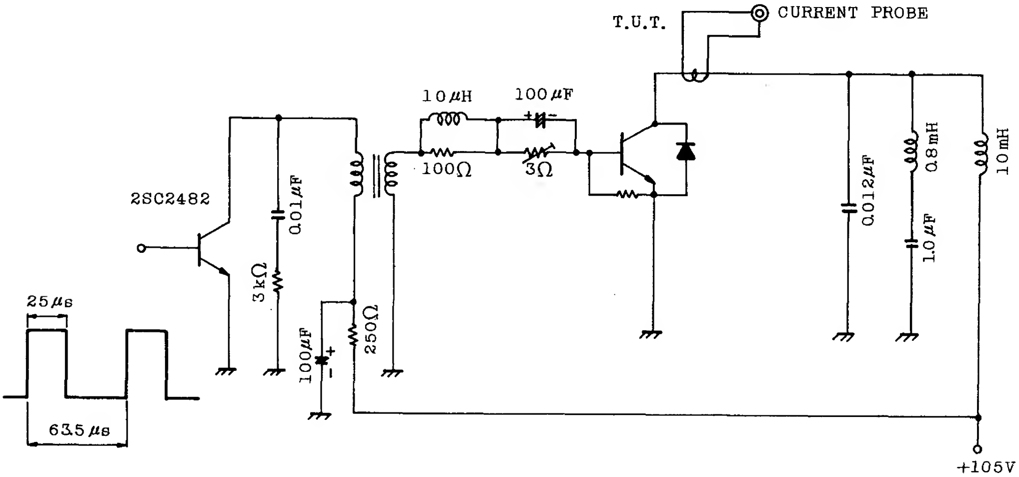
EQUIVALENT CIRCUIT



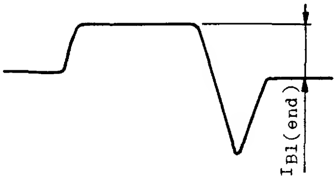
ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1.0A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.8A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=5A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=4A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

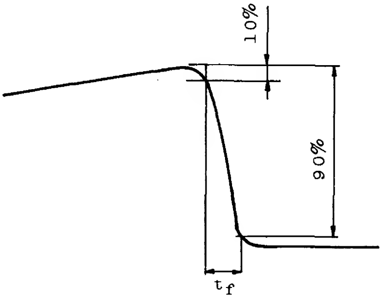
Fig. t_f TEST CONDITION

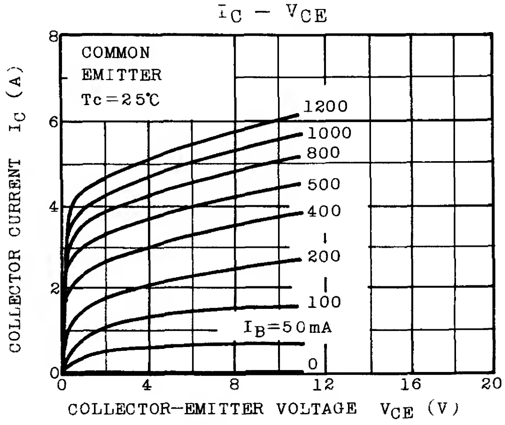


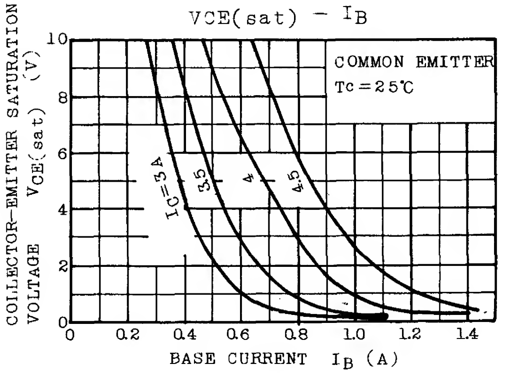
BASE CURRENT

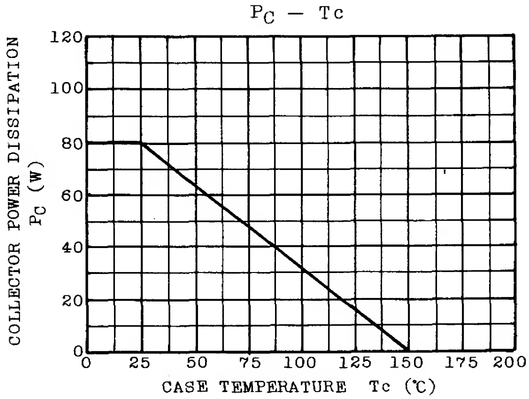


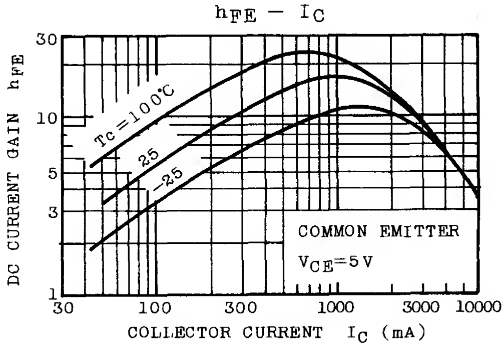
COLLECTOR CURRENT

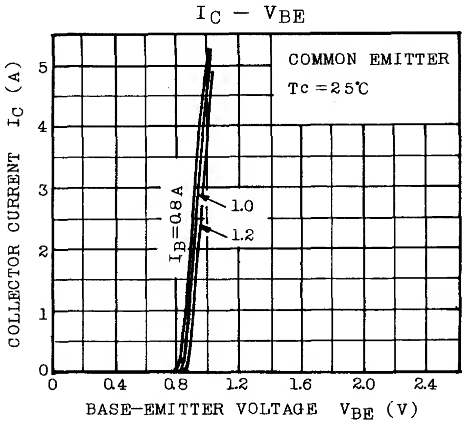


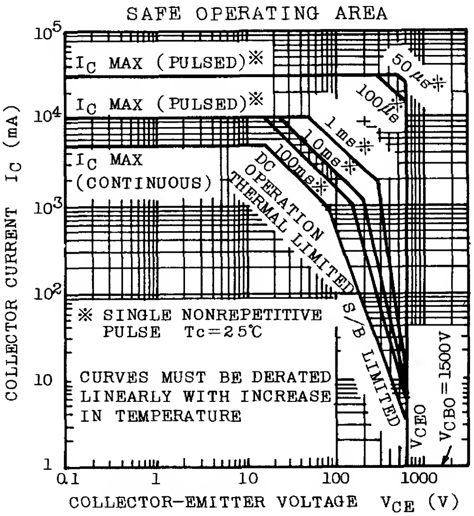

I_C − V_{CE}
COMMON
EMITTER
Tc = 25℃
COLLECTOR CURRENT I_C (A)
0
2
4
6
8
1200
1000
800
500
400
200
100
I_B=50mA
0
4
8
12
16
20
COLLECTOR−EMITTER VOLTAGE V_{CE} (V)


VCE(sat) − I_B
COMMON EMITTER
Tc = 25℃
COLLECTOR−EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0
2
4
6
8
10
I_C=3A
3.5
4
4.5
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE CURRENT I_B (A)


P_C − Tc
COLLECTOR POWER DISSIPATION P_C (W)
0
20
40
60
80
100
120
0
25
50
75
100
125
150
175
200
CASE TEMPERATURE Tc (℃)


h_{FE} − I_C
DC CURRENT GAIN h_{FE}
1
3
5
10
30
Tc=100℃
25
−25
COMMON EMITTER
V_{CE}=5V
30
100
300
1000
3000
10000
COLLECTOR CURRENT I_C (mA)


I_C − V_{BE}
COMMON EMITTER
Tc = 25℃
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
5
I_B=0.8A
1.0
1.2
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE−EMITTER VOLTAGE V_{BE} (V)


SAFE OPERATING AREA
COLLECTOR CURRENT I_C (mA)
1
10
10^2
10^3
10^4
10^5
I_C MAX (PULSED)※
I_C MAX (PULSED)※
I_C MAX (CONTINUOUS)
50μs※
100μs※
1ms※
10ms※
100ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
V_{CEO}
V_{CBO}=1500V
0.1
1
10
100
1000
COLLECTOR−EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

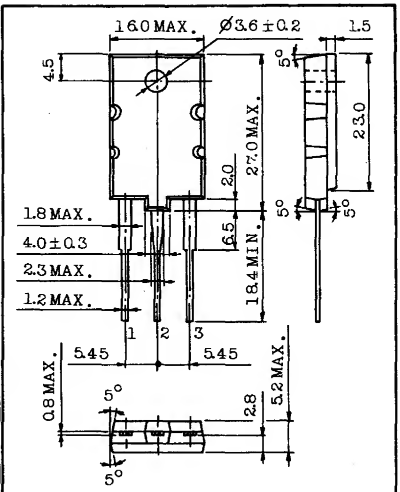
2SD1428

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V(Max.) (I_C=5A, I_B=1A)
- High Speed : t_f=1.0μs(Max.)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

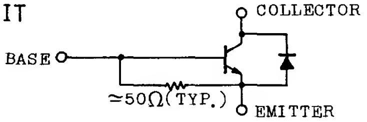
JEDEC	–
EIAJ	–
TOSHIBA	2–16D1A

Weight : 5.2g

MAXIMUM RATINGS (T_c=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

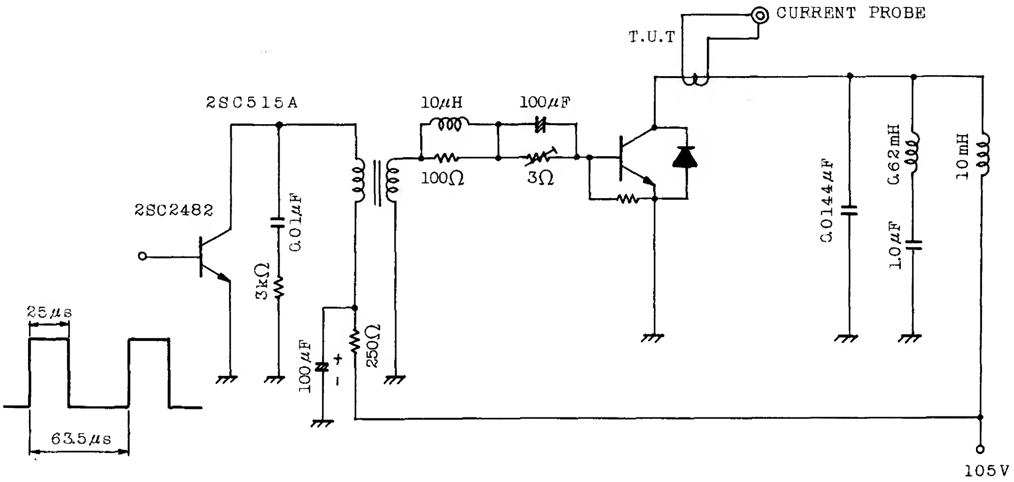
EQUIVALENT CIRCUIT



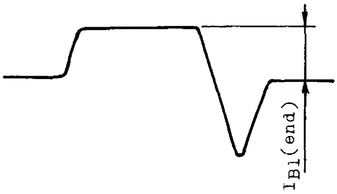
ELECTRICAL CHARACTERISTICS (T_c=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=1A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	I_F=6A	-	1.6	2.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=5A, $I_{B1(end)}$=1A	-	0.5	1.0	μs

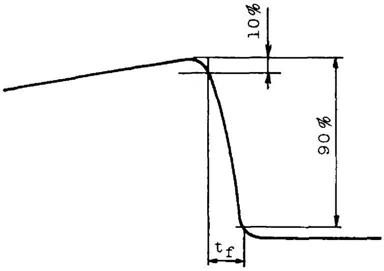
Fig. t_f TEST CIRCUIT



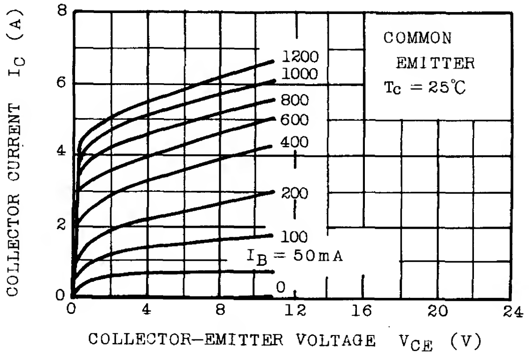
BASE CURRENT



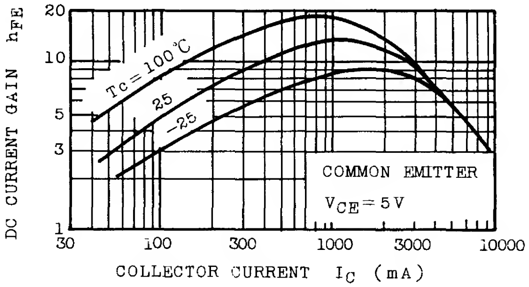
COLLECTOR CURRENT



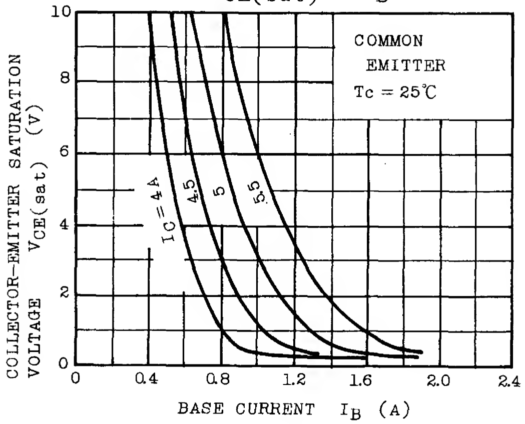
IC — VCE



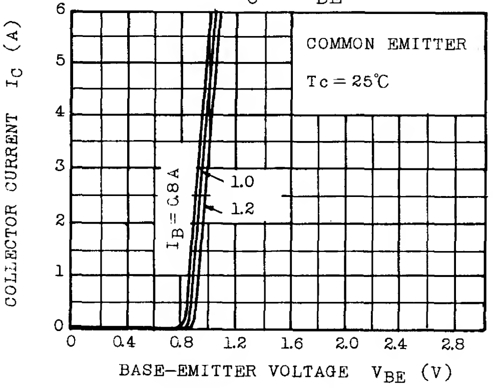
hFE — IC



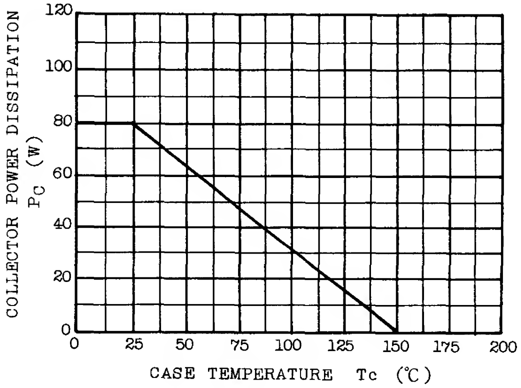
VCE(sat) — IB



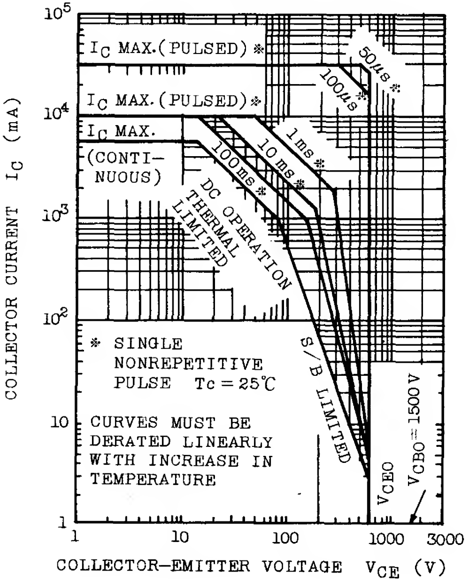
IC — VBE



PC — Tc



SAFE OPERATING AREA



2SD1429

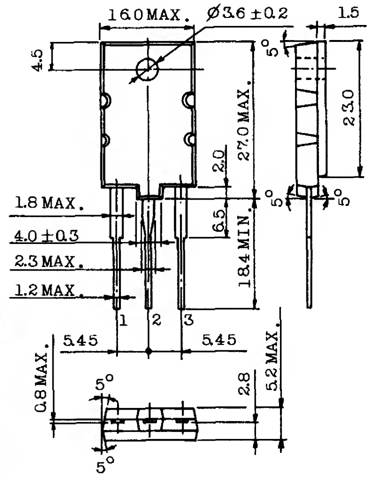
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=4V (Typ.)
- High Speed : t_f=0.5μs (Typ.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-16D1A

Weight : 5.2g

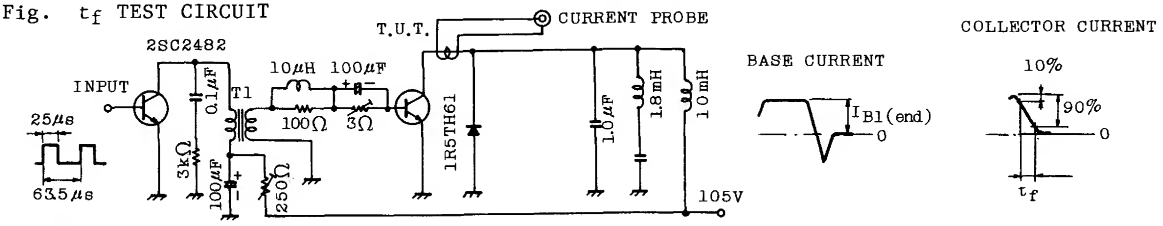
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2.0A, I_B=0.6A	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2.0A, I_B=0.6A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time (Fig.)	t_f	I_{CP}=2.0A,$I_{B1(end)}$=0.6A	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



SILICON NPNTRIPLE DIFFUSED MESA TYPE

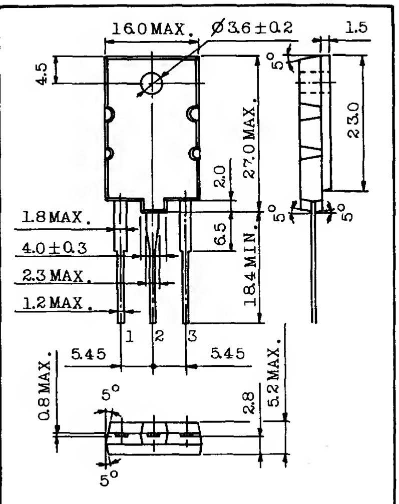
2SD1430

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=4V (Typ.) (I_C=3A, I_B=0.8A)
- High Speed : t_f=1.0μs (Max.) (I_{CP}=3A, $I_{B1(end)}$=0.8A)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2–16D1A

Weight : 5.2g

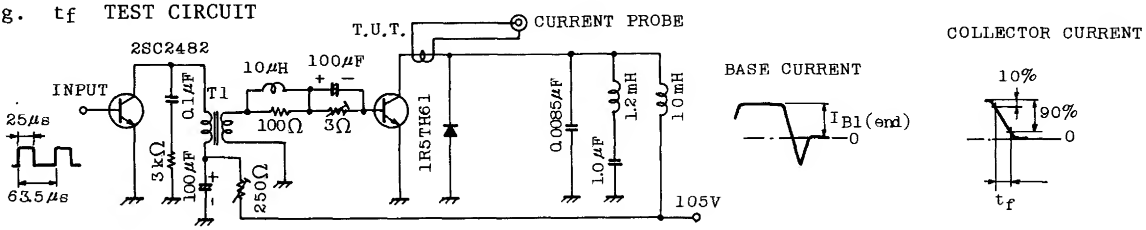
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temeprature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=0.5A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.8A	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=3A, I_B=0.8A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Fall Time (Fig.)	t_f	I_{CP}=3A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

Fig. tf TEST CIRCUIT



2SD1431

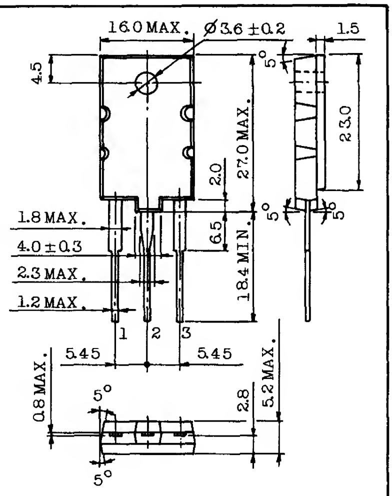
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V(Max.) (I_C=4A, I_B=0.8A)
- High Speed : t_f=1.0μs(Max.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	—
EIAJ	—
TOSHIBA	2-16D1A

Weight : 5.2g

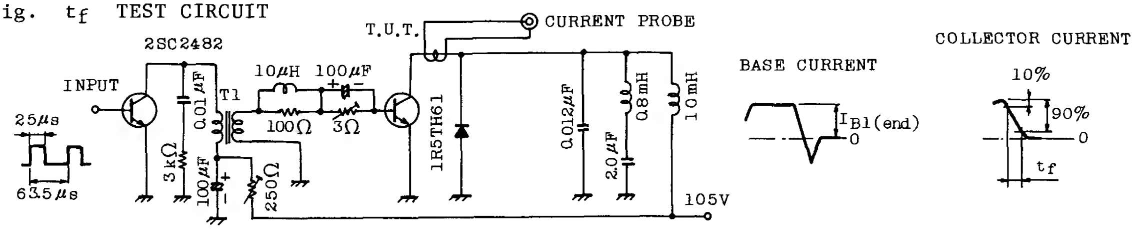
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.8A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=0.8A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=4A, $I_{B1(end)}$=0.8A	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



SILICON NPN TRIPLE DIFFUSED MESA TYPE

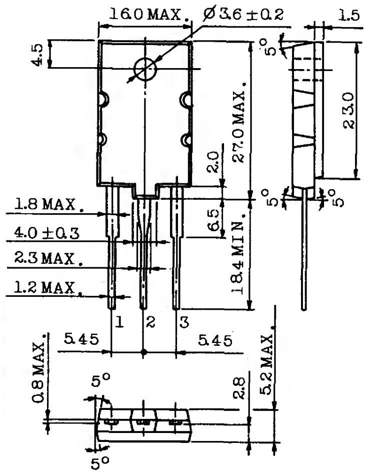
2SD1432

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V (Max.) (I_C=5A, I_B=1A)
- High Speed : t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2-16D1A

Weight : 5.2g

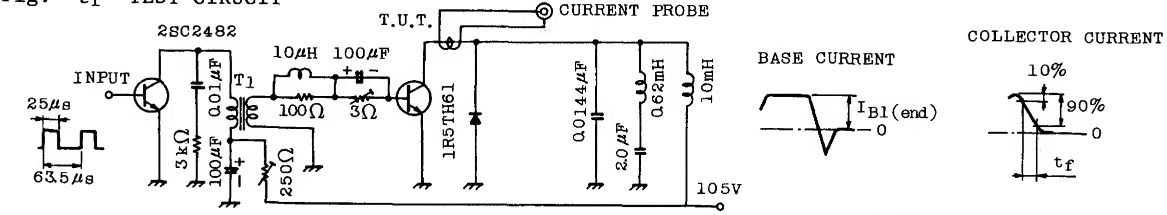
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation (T_c=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=5A, I_B=1A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=5A, I_B=1A	-	-	1.5	V
Transition Frequency	f_t	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=5A, $I_{B1(end)}$=1A	-	0.5	1.0	μs

Fig. tf TEST CIRUICT



2SD1433

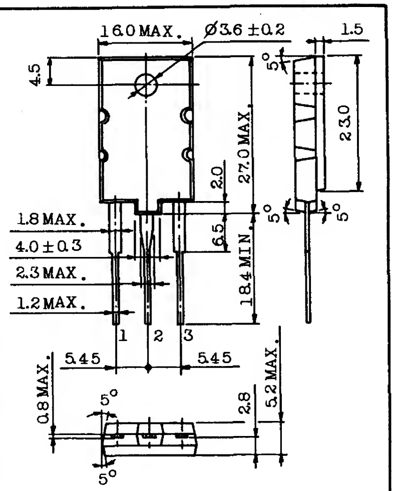
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=1500V
- Low Saturation Voltage
  : $V_{CE(sat)}$=5V (Max.) (I_C=6A, I_B=1.2A)
- High Speed : t_f=1.0μs (Max.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−16D1A

Weight : 5.2g

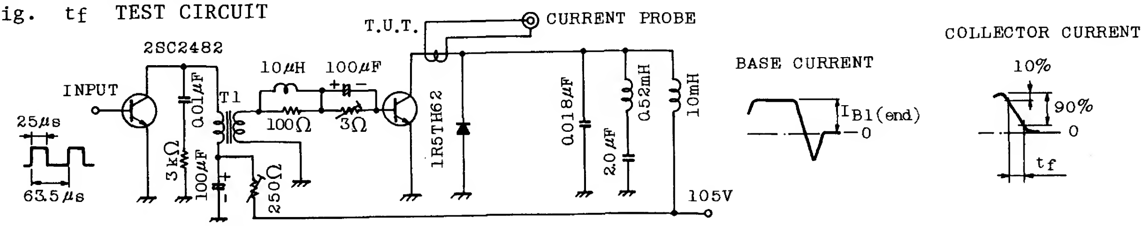
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector Power Dissipation (Tc=25°C)	P_C	80	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=500V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=1A	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=6A, I_B=1.2A	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=6A, I_B=1.2A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	3	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Fall Time (Fig.)	t_f	I_{CP}=6A, $I_{B1(end)}$=1.2A	-	0.5	1.0	μs

Fig. tf TEST CIRCUIT



SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

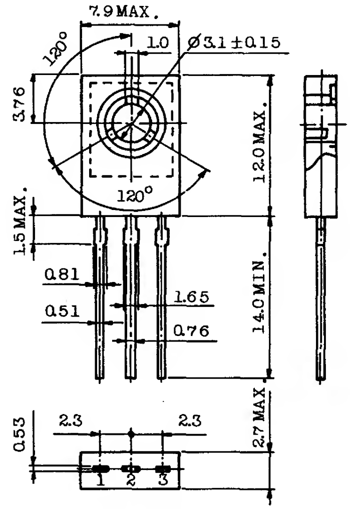
2SD1438

MICRO MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
  : h_{FE}=2000(Min.) (V_{CE}=2V, I_C=1A)
- Low Saturation Voltage
  : $V_{CE(sat)}$=1.5V(Max.) (I_C=1A, I_B=1mA)

INDUSTRIAL APPLICATIONS
Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

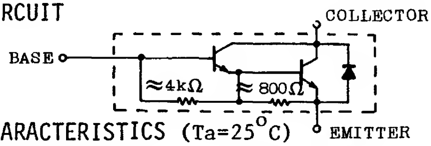
JEDEC	TO-126
EIAJ	–
TOSHIBA	2-8F1A

Mounting Kit No. AC46C
Weight : 0.72g

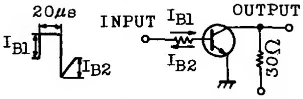
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	8	V
Collector Current	I_C	2	A
Base Current	I_B	0.5	A
Collector Power Dissipation (T_c=25°C)	P_C	15	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

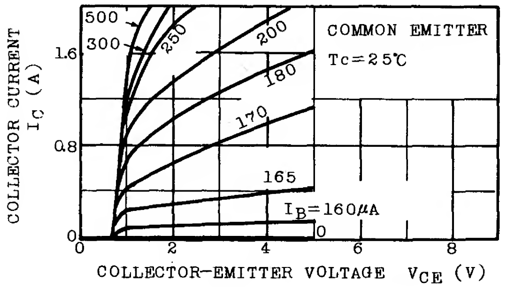
EQUIVALENT CIRCUIT



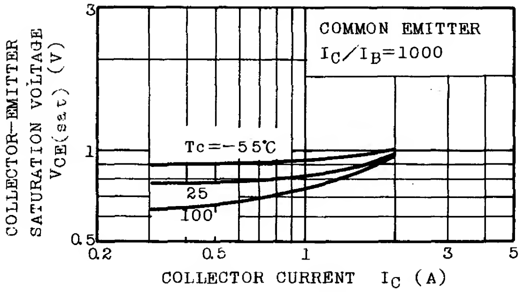
ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	–	–	10	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=8V, I_C=0	–	–	4	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	–	–	V
DC Current Gain		h_{FE}	V_{CE}=2V, I_C=1A	2000	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=1mA	–	–	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=1A, I_B=1mA	–	–	2.0	V
Transition Frequency		f_T	V_{CE}=2V, I_C=0.5A	–	100	–	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	–	20	–	pF
Switching Time	Turn-on Time	t_{on}	 20μs INPUT I_{B1} I_{B2} OUTPUT 30Ω I_{B1} I_{B2} I_{B1}=−I_{B2}=1mA V_{CC}=30V DUTY CYCLE≦1%	–	0.4	–	μs
	Storage Time	t_{stg}		–	4.0	–	
	Fall Time	t_f		–	0.6	–	

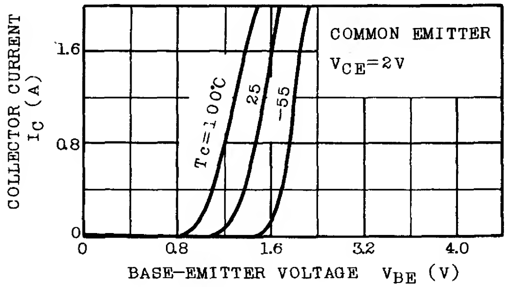
I_C — V_{CE}



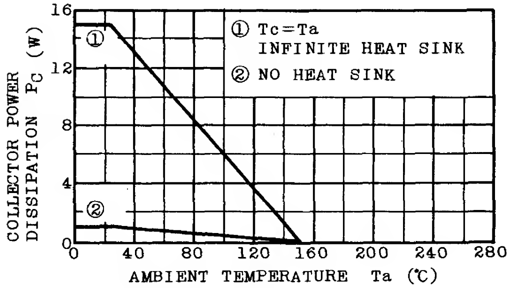
$V_{CE(sat)}$ — I_C



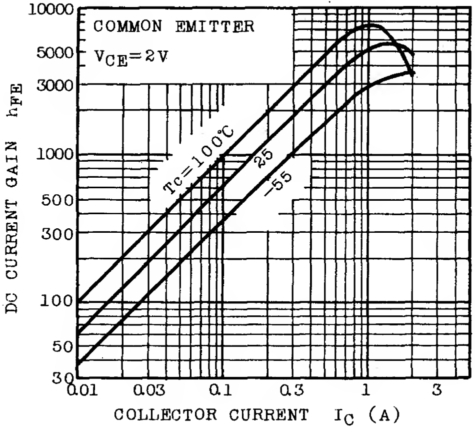
I_C — V_{BE}



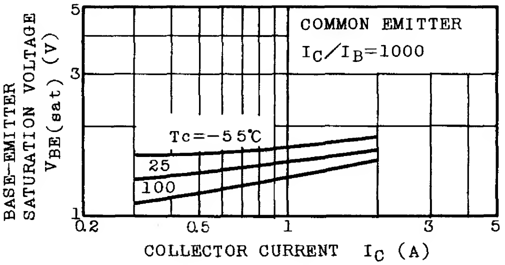
P_C — Ta



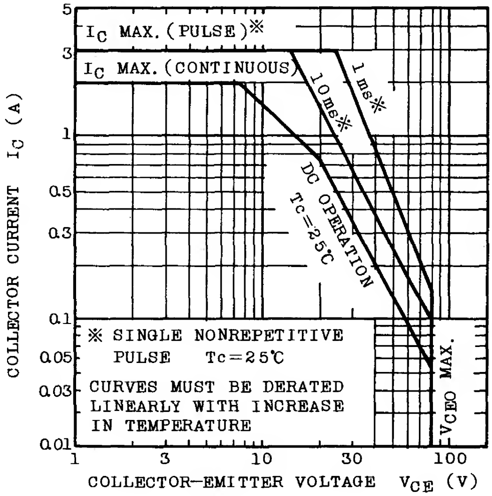
h_{FE} — I_C



$V_{BE(sat)}$ — I_C



SAFE OPERATING AREA



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

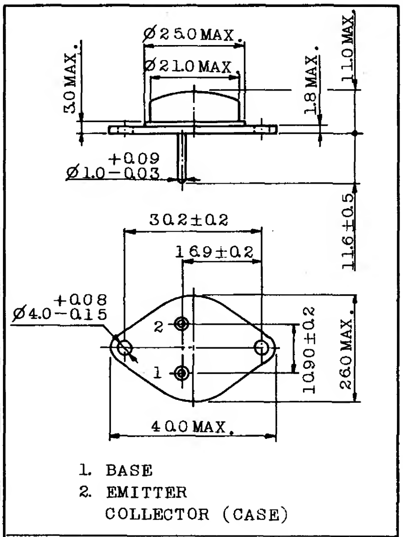
2SD1460

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- High Collector Current : I_C=30A
- High DC Current Gain : h_{FE}=1000(Min.)(V_{CE}=5V, I_C=20A)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

Unit in mm



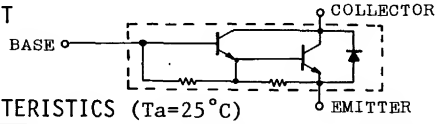
JEDEC		TO−3
EIAJ		TC−3, TB−3
TOSHIBA		2−21A1A

Mounting Kit No. AC73
Weight : 13g

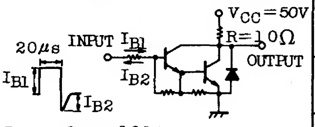
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	30	A
Base Current	I_B	5	A
Collector Power Dissipation (Tc=25°C)	P_C	200	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−65～150	°C

EQUIVALENT CIRCUIT

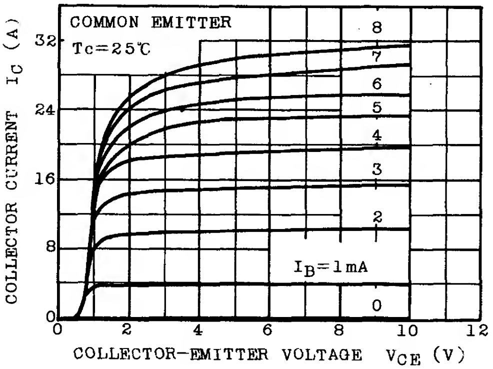


ELECTRICAL CHARACTERISTICS (Ta=25°C)

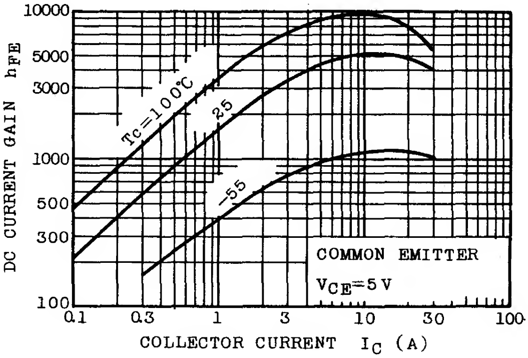
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=100V, I_E=0	−	−	100	μA
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	10	mA
Collector-Emitter Breakdwon Voltage		$V_{(BR)CEO}$	I_C=50mA, I_B=0	100	−	−	V
DC Current Gain		$h_{FE(1)}$	V_{CE}=5V, I_C=20A	1000	−	−	
		$h_{FE(2)}$	V_{CE}=5V, I_C=30A	200	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=20A, I_B=0.2A	−	−	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		−	−	2.0	V
Emitter-Collector Forward Voltage		V_{ECF}	I_E=10A, I_B=0	−	−	3	V
Transition Frequency		f_T	V_{CE}=5V, I_C=1A	−	10	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	500	−	pF
Switching Time	Turn on Time	t_{on}	 V_{CC}=50V R=10Ω 20μs INPUT I_{B1} I_{B2} OUTPUT I_{B1}=−I_{B2}=0.01A DUTY CYCLE≦1%	−	1.5	−	μs
	Storage Time	t_{stg}		−	10	−	
	Fall Time	t_f		−	1.5	−	

TOSHIBA CORPORATION

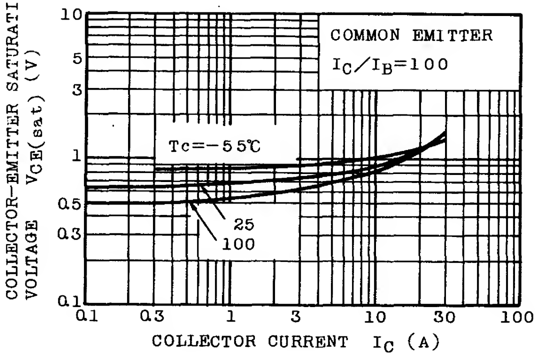
$I_C - V_{CE}$



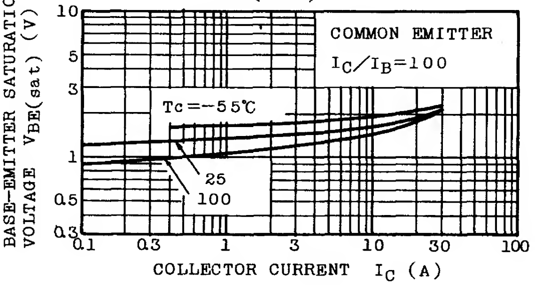
$h_{FE} - I_C$



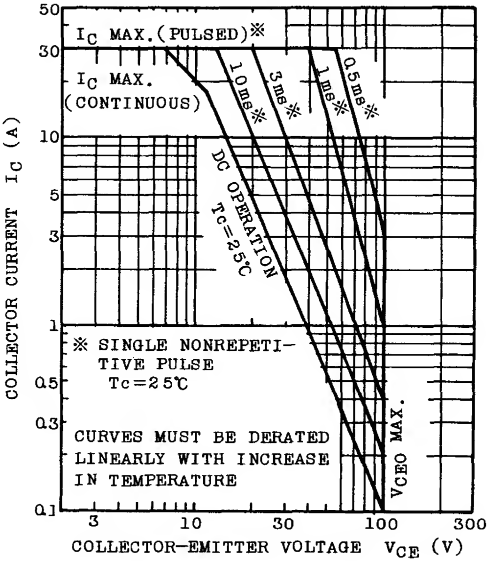
$V_{CE(sat)} - I_C$



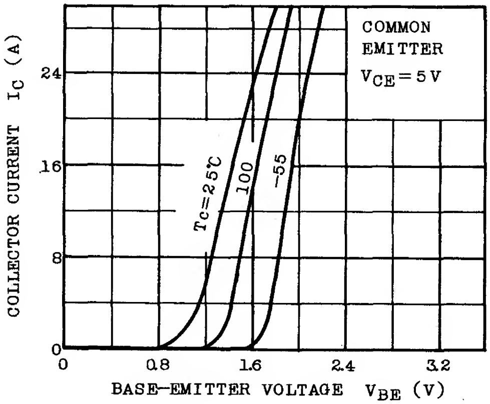
$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



$I_C - V_{BE}$



2SJ
SERIES

SILICON P CHANNEL MOS TYPE

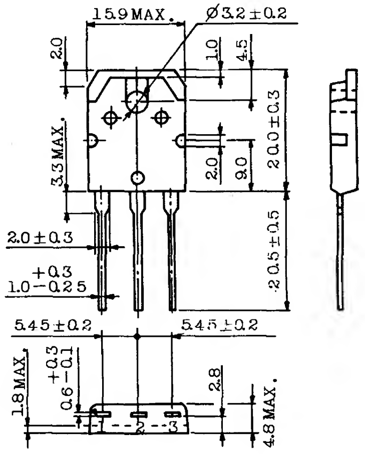
2SJ115

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

FEATURES:

- High Breakdown Voltage : V_{DSS}=-160V
- High Forward Transfer Admittance : $|Y_{fs}|$=2.0S (Typ.)
- Complementary to 2SK405

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	―
EIAJ	―
TOSHIBA	2−16C1B

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

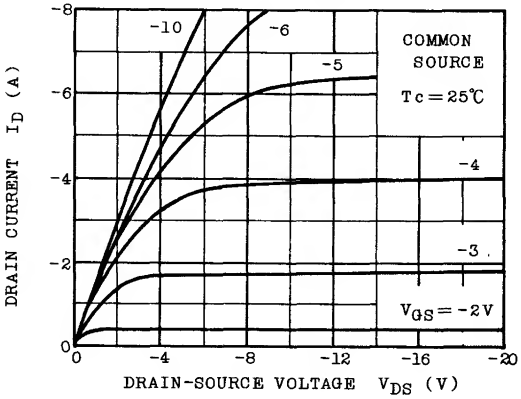
CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSS}	-160	V
Gate-Source Voltage	V_{GSS}	±20	V
Drain Current	I_D	-8	A
Power Dissipation (Tc=25°C)	P_D	100	W
Channel Temperature	Tch	150	°C
Storage Temperature Range	Tstg	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

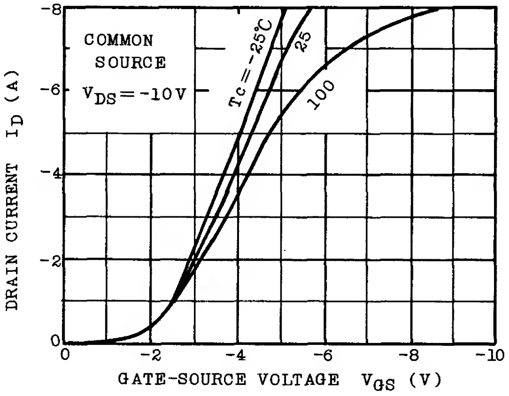
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I_{GSS}	V_{DS}=0, V_{GS}=±20V	-	-	±1.0	μA
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	I_D=-5mA, V_{GS}=0	-160	-	-	V
Gate-Source Cut-off Voltage	$V_{GS(OFF)}$ (Note)	V_{DS}=-10V, I_D=-0.1A	-0.8	-	-2.8	V
Drain-Source Saturation Voltage	$V_{DS(ON)}$	I_D=-5A, V_{GS}=-10V	-	-3.5	-7.0	V
Forward Transfer Admittance	$\|Y_{fs}\|$	V_{DS}=-10V, I_D=-2A	1.0	2.0	-	S
Input Capacitance	Ciss	V_{DS}=-10V, V_{GS}=0, f=1MHz	-	800	-	pF
Output Capacitance	Coss	V_{DS}=-10V, V_{GS}=0, f=1MHz	-	500	-	pF
Reverse Transfer Capacitance	Crs	V_{DS}=-10V, V_{GS}=0, f=1MHz	-	110	-	pF

Note : $V_{GS(OFF)}$ Classification O : -0.8～-1.6, Y : -1.4～-2.8

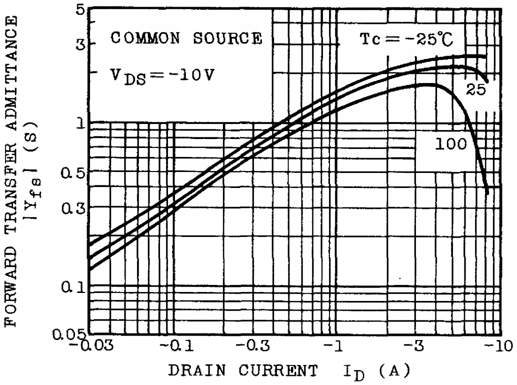
$I_D - V_{DS}$



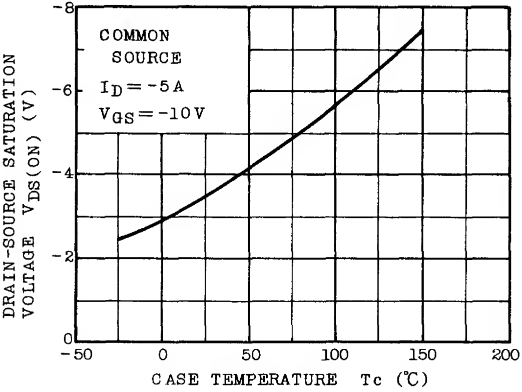
$I_D - V_{GS}$



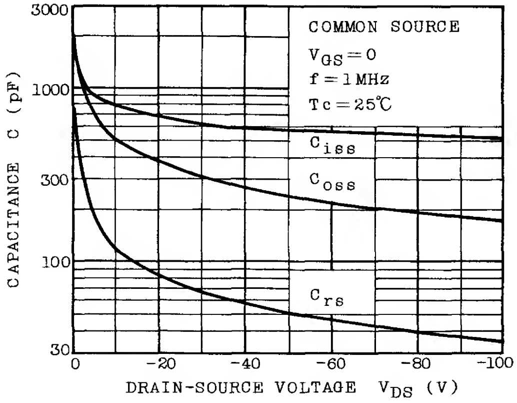
$|Y_{fs}| - I_D$



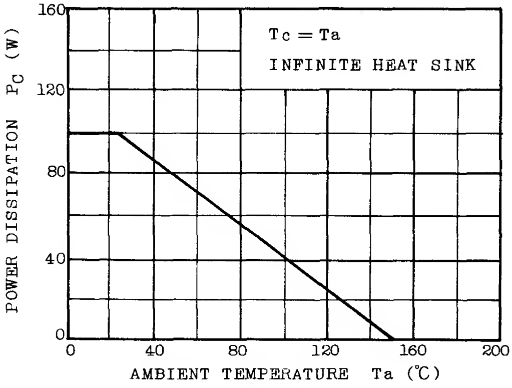
$V_{DS(ON)} - T_c$

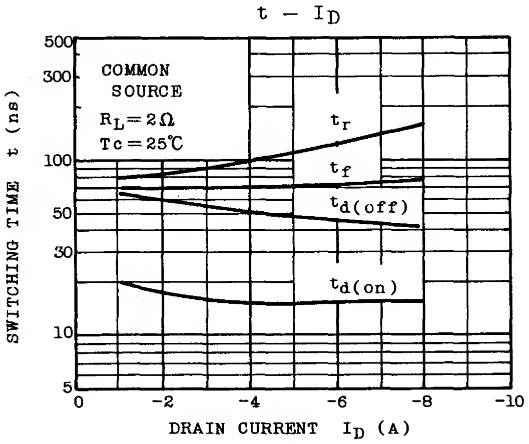


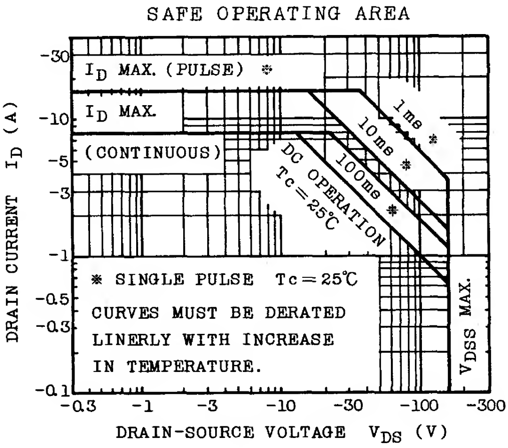
$C - V_{DS}$

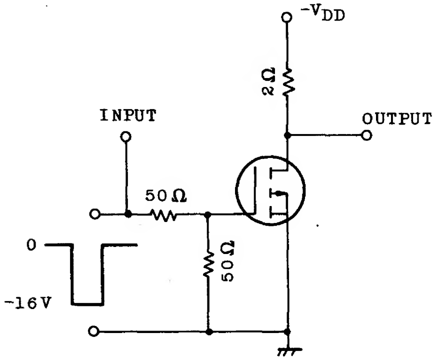


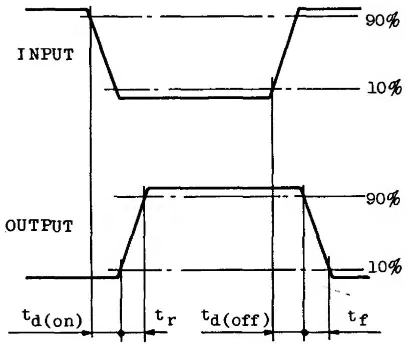
$P_D - T_a$




t — ID
COMMON SOURCE
RL = 2Ω
Tc = 25℃
tr
tf
td(off)
td(on)
SWITCHING TIME t (ns)
500
300
100
50
30
10
5
0
-2
-4
-6
-8
-10
DRAIN CURRENT ID (A)


SAFE OPERATING AREA
ID MAX. (PULSE) ⁕
ID MAX.
(CONTINUOUS)
1ms ⁕
10ms ⁕
100ms ⁕
DC OPERATION Tc = 25℃
⁕ SINGLE PULSE Tc = 25℃
CURVES MUST BE DERATED LINERLY WITH INCREASE IN TEMPERATURE.
VDSS MAX.
DRAIN CURRENT ID (A)
-30
-10
-5
-3
-1
-0.5
-0.3
-0.1
-0.3
-1
-3
-10
-30
-100
-300
DRAIN-SOURCE VOLTAGE VDS (V)


-VDD
2Ω
INPUT
OUTPUT
50Ω
50Ω
0
-16V


INPUT
OUTPUT
90%
10%
90%
10%
td(on)
tr
td(off)
tf

2SK

SERIES

SILICON N CHANNEL MOS TYPE (π-MOS)

2SK324

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

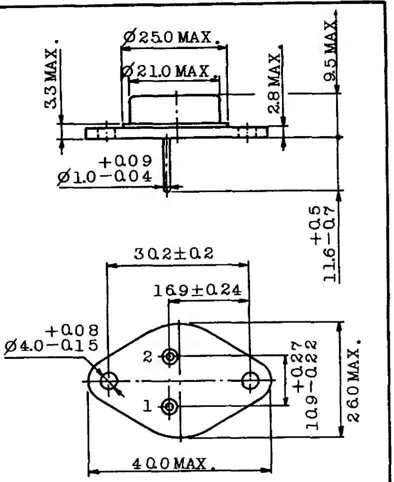
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}=400V$
- High Forward Transfer Admittance : $|Y_{fs}|=5S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm100nA$ (Max.) @ $V_{GS}=\pm20V$
  $I_{DSS}=1mA$ (Max.) @ $V_{DS}=400V$
- Enhancement-Mode : $V_{th}=1.5\sim3.5V$ @ $I_D=1mA$

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. SOURCE
   DRAIN (CASE)

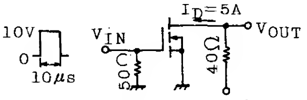
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1B

Weight : 15.8g

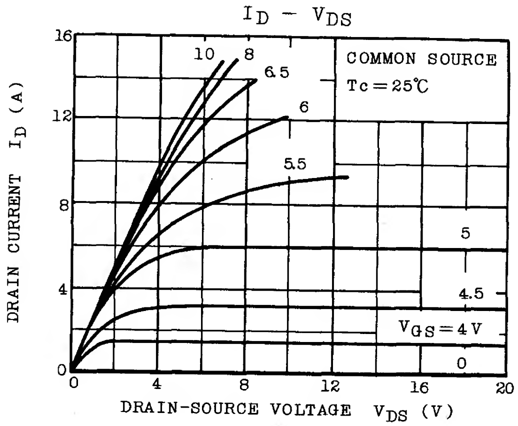
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-65 ~ 150	°C

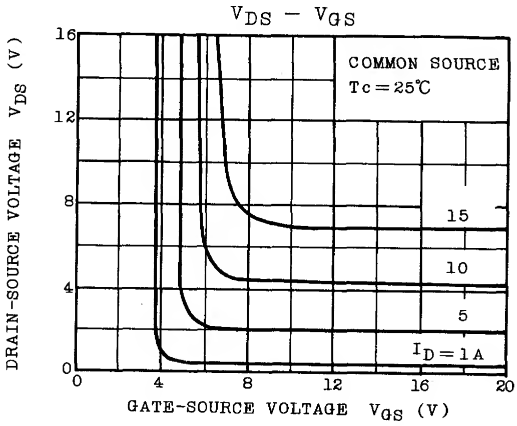
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm20V$, $V_{DS}=0$	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=400V$, $V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA$, $V_{GS}=0$	400	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V$, $I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	$V_{DS}=10V$, $I_D=5A$	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=5A$, $V_{GS}=10V$	-	0.45	0.6	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A$, $V_{GS}=10V$	-	5	7	V
Input Capacitance		C_{iss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	1500	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	140	300	pF
Output Capacitance		C_{oss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	400	600	pF
Switching Time	Rise Time	t_r	 $I_D\doteq5A$ 10V 0 10μs V_{IN} 50Ω 40Ω V_{OUT} V_{IN}: t_r, t_f < 5ns $V_{DD}\doteq200V$ D.U≦1% ($Z_{OUT}=50\Omega$)	-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns

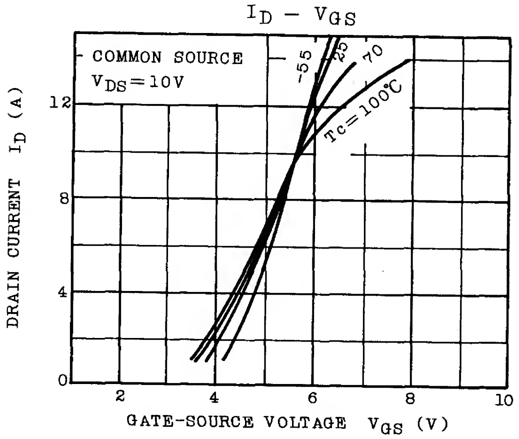
TOSHIBA CORPORATION



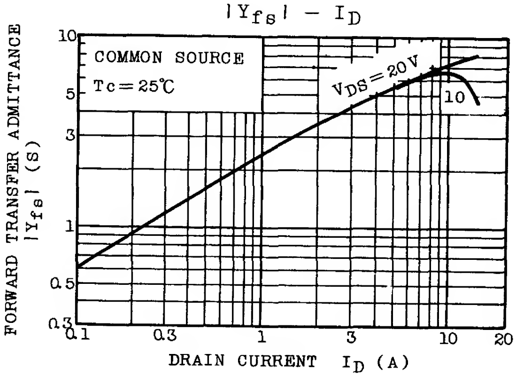
I_D – V_{DS}
COMMON SOURCE
Tc = 25℃
10
8
6.5
6
5.5
5
4.5
V_{GS} = 4 V
0
16
12
8
4
0
0
4
8
12
16
20
DRAIN CURRENT I_D (A)
DRAIN-SOURCE VOLTAGE V_{DS} (V)



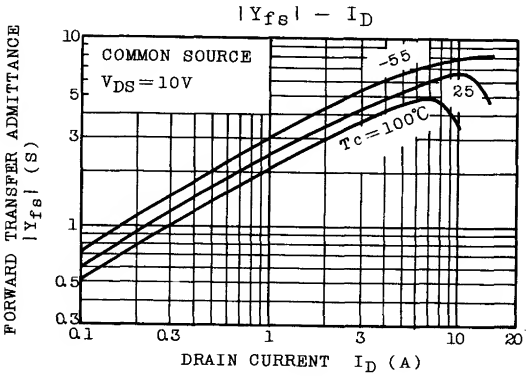
V_{DS} – V_{GS}
COMMON SOURCE
Tc = 25℃
15
10
5
I_D = 1 A
16
12
8
4
0
0
4
8
12
16
20
DRAIN-SOURCE VOLTAGE V_{DS} (V)
GATE-SOURCE VOLTAGE V_{GS} (V)



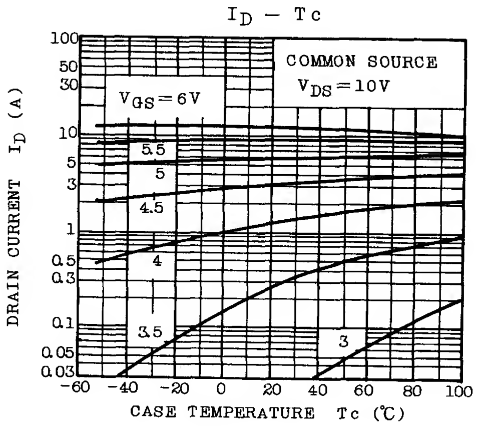
I_D – V_{GS}
COMMON SOURCE
V_{DS} = 10 V
-55
25
70
Tc = 100℃
12
8
4
0
2
4
6
8
10
DRAIN CURRENT I_D (A)
GATE-SOURCE VOLTAGE V_{GS} (V)



$|Y_{fs}|$ – I_D
COMMON SOURCE
Tc = 25℃
V_{DS} = 20 V
10
10
5
3
1
0.5
0.3
0.1
0.3
1
3
10
20
FORWARD TRANSFER ADMITTANCE $|Y_{fs}|$ (S)
DRAIN CURRENT I_D (A)

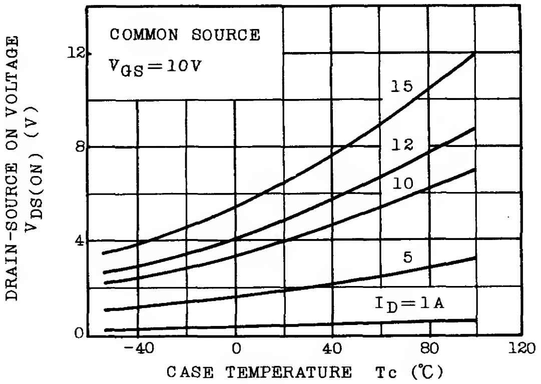


$|Y_{fs}|$ – I_D
COMMON SOURCE
V_{DS} = 10 V
-55
25
Tc = 100℃
10
5
3
1
0.5
0.3
0.1
0.3
1
3
10
20
FORWARD TRANSFER ADMITTANCE $|Y_{fs}|$ (S)
DRAIN CURRENT I_D (A)

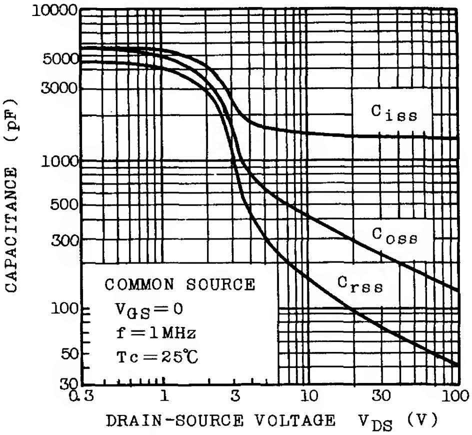


I_D – Tc
COMMON SOURCE
V_{DS} = 10 V
V_{GS} = 6 V
5.5
5
4.5
4
3.5
3
100
50
30
10
5
3
1
0.5
0.3
0.1
0.05
0.03
-60
-40
-20
0
20
40
60
80
100
DRAIN CURRENT I_D (A)
CASE TEMPERATURE Tc (℃)

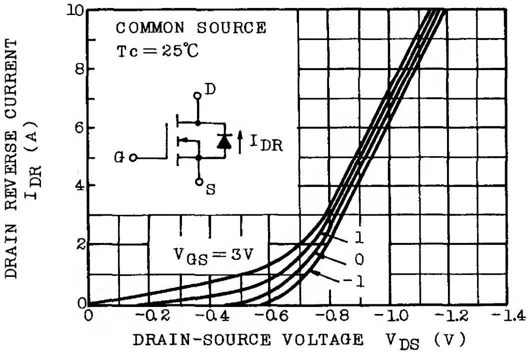
$V_{DS(ON)}$ – Tc



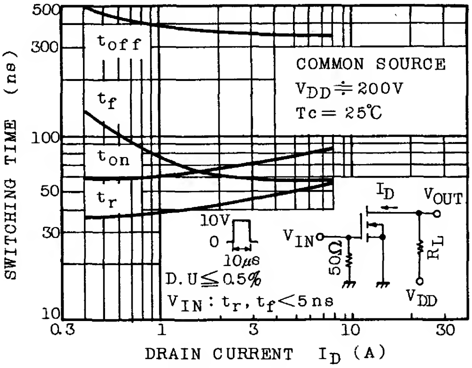
CAPACITANCE – V_{DS}



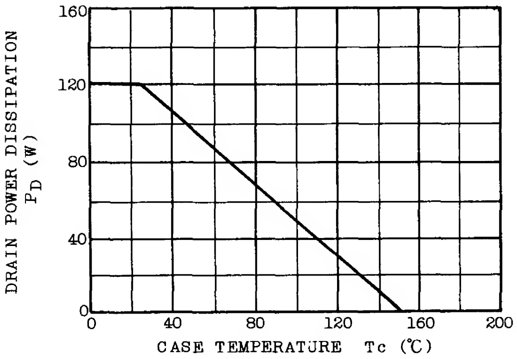
I_{DR} – V_{DS}



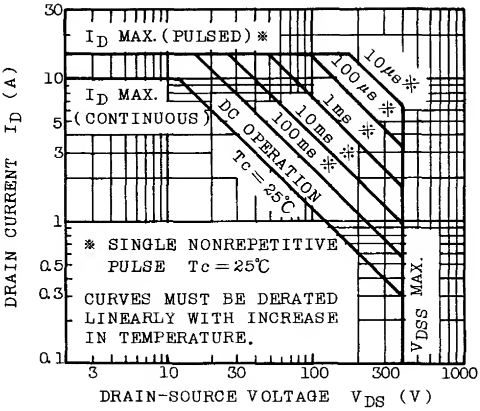
SWITCHING TIME – I_D



P_D – Tc



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.

2SK325

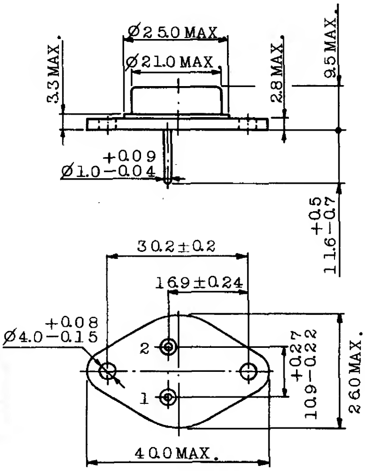
SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. SOURCE
DRAIN (CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21E1B

Weight : 15.8g

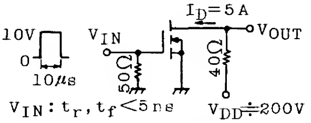
FEATURES:

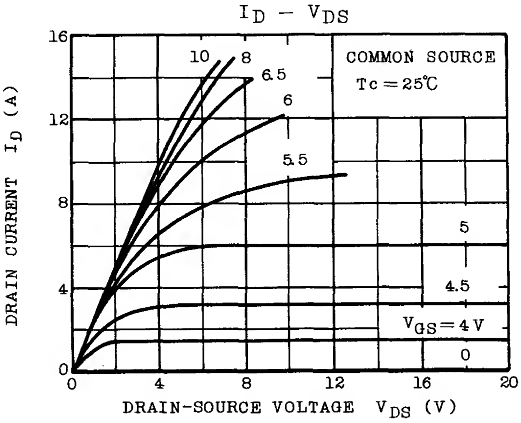
- High Breakdown Voltage : $V_{(BR)DSS}$=450V
- High Forward Transfer Admittance : $|Y_{fs}|$=5S(Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=450V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

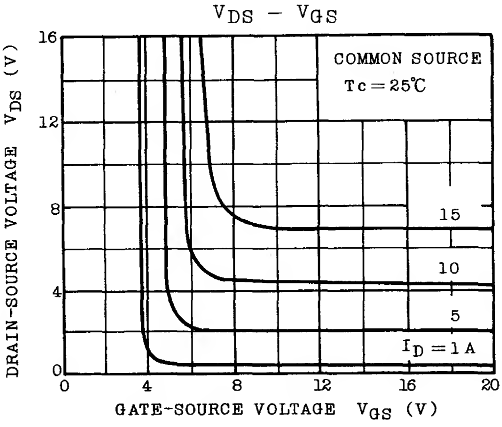
MAXIMUM RATINGS (Ta=25°C)

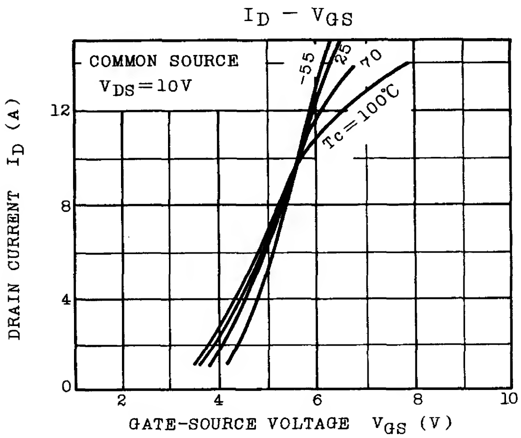
CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		Tch	150	°C
Storage Temperature Range		Tstg	-65～150	°C

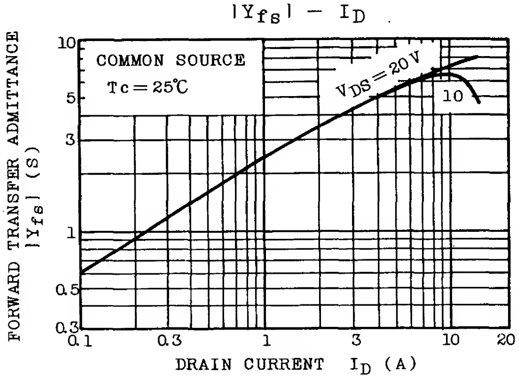
ELECTRICAL CHARACTERISTICS (Ta=25°C)

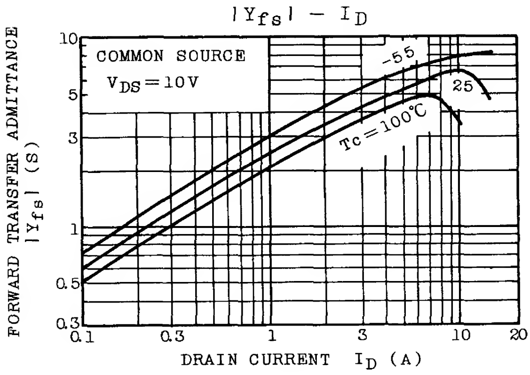
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=450V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	450	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D 1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=5A	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=5A, V_{GS}=10V	-	0.5	0.7	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	5.5	8	V
Input Capacitance		Ciss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	1500	2000	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	140	300	pF
Output Capacitance		Coss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	400	600	pF
Switching Time	Rise Time	t_r	 I_D=5A 10V 0 10μs V_{IN} V_{OUT} 50Ω 40Ω V_{IN} : t_r, t_f<5ns V_{DD}≑200V D.U≦1% (Z_{OUT}=50Ω)	-	50	100	ns
	Turn-on Time	ton		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	toff		-	350	700	ns

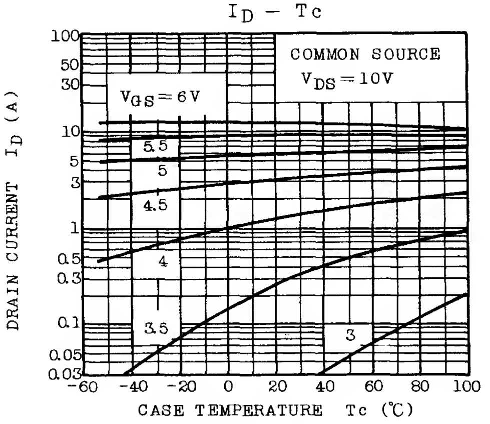

ID – VDS
COMMON SOURCE
Tc=25℃
10
8
6.5
6
5.5
5
4.5
VGS=4V
0
DRAIN CURRENT ID (A)
DRAIN-SOURCE VOLTAGE VDS (V)
0
4
8
12
16
20


VDS – VGS
COMMON SOURCE
Tc=25℃
15
10
5
ID=1A
DRAIN-SOURCE VOLTAGE VDS (V)
GATE-SOURCE VOLTAGE VGS (V)
0
4
8
12
16
20

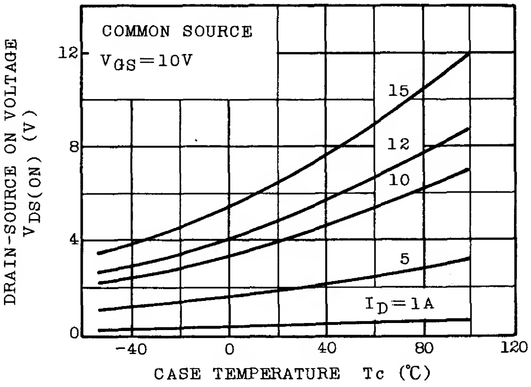

ID – VGS
COMMON SOURCE
VDS=10V
-55
25
70
Tc=100℃
DRAIN CURRENT ID (A)
GATE-SOURCE VOLTAGE VGS (V)
0
4
8
12
2
4
6
8
10


|Yfs| – ID
COMMON SOURCE
Tc=25℃
VDS=20V
10
FORWARD TRANSFER ADMITTANCE |Yfs| (S)
DRAIN CURRENT ID (A)
0.3
0.5
1
3
5
10
0.1
0.3
1
3
10
20

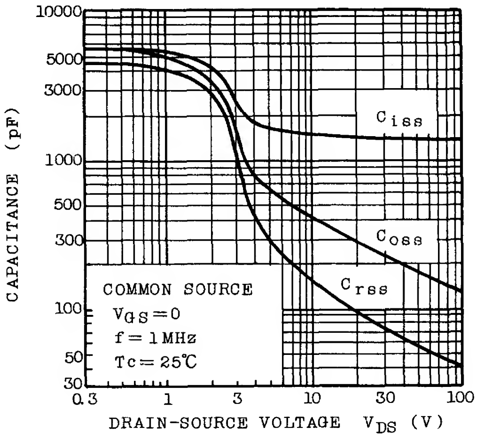

|Yfs| – ID
COMMON SOURCE
VDS=10V
-55
25
Tc=100℃
FORWARD TRANSFER ADMITTANCE |Yfs| (S)
DRAIN CURRENT ID (A)
0.3
0.5
1
3
5
10
0.1
0.3
1
3
10
20


ID – Tc
COMMON SOURCE
VDS=10V
VGS=6V
5.5
5
4.5
4
3.5
3
DRAIN CURRENT ID (A)
CASE TEMPERATURE Tc (℃)
0.03
0.05
0.1
0.3
0.5
1
3
5
10
30
50
100
-60
-40
-20
0
20
40
60
80
100

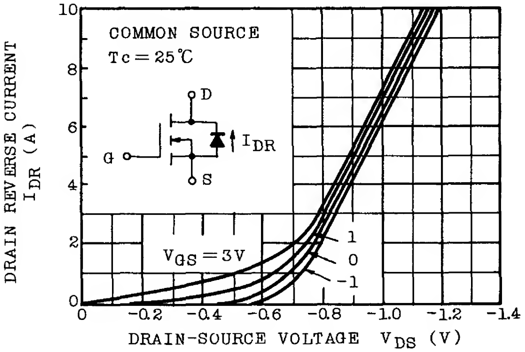
$V_{DS(ON)}$ − Tc



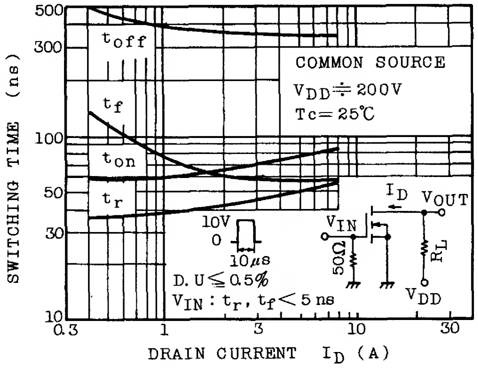
CAPACITANCE − V_{DS}



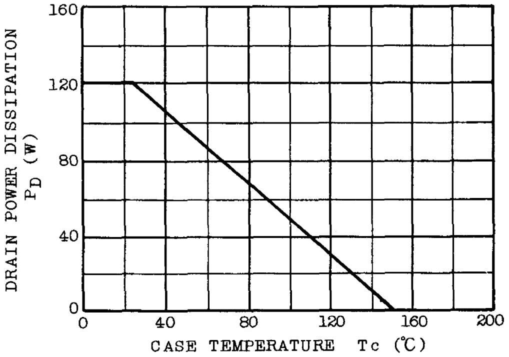
I_{DR} − V_{DS}



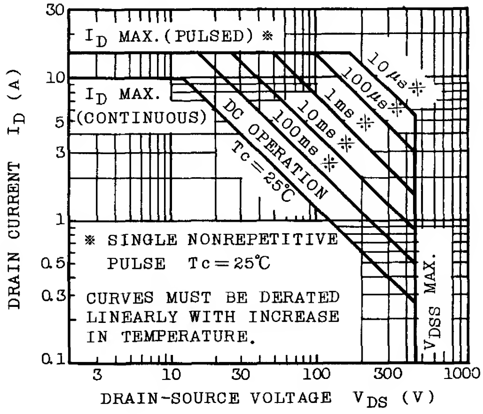
SWITCHING TIME − I_D



P_D − Tc



SAFE OPERATING AREA



SILICON N CHANNEL MOS TYPE (π-MOS)

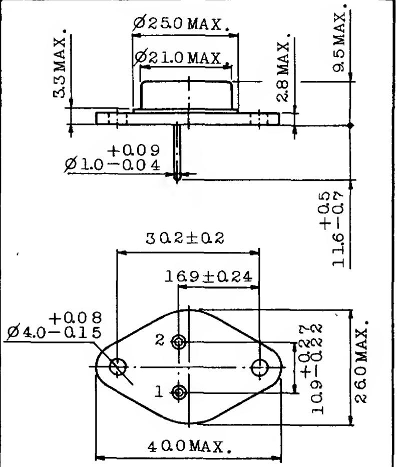
2SK355

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. SOURCE
DRAIN (CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21E1B

Weight : 15.8g

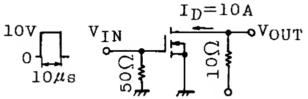
FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}$=0.12Ω(Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|$=6S(Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=150V
- Enhancement-Mode : V_{th}=1.5 ~ 3.5V @ I_D=1mA

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	150	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	40	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		Tch	150	°C
Storage Temperature Range		Tstg	-65 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=150V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	150	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=10A	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	0.12	0.18	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	1.2	1.8	V
Input Capacitance		Ciss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	1600	2200	pF
Reverse Transfer Capacitance		Crss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	350	600	pF
Output Capacitance		Coss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	800	1300	pF
Switching Time	Rise Time	t_r	 V_{IN} : t_r, t_f<5ns D.U≤1% (Z_{OUT}=50Ω)	-	120	260	ns
	Turn-on Time	t_{on}		-	150	300	ns
	Fall Time	t_f		-	120	240	ns
	Turn-off Time	t_{off}		-	300	600	ns

TOSHIBA CORPORATION

2SK356

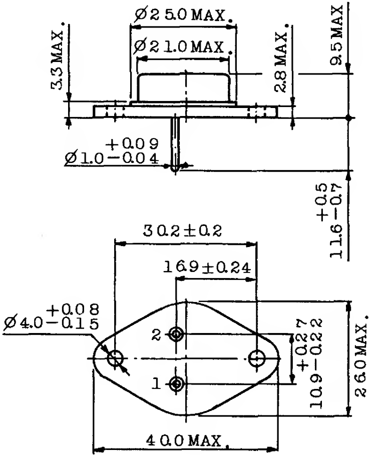
SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DTIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. SOURCE
DRAIN (CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21E1B

Weight : 15.8g

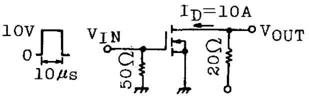
FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.2\Omega$(Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|=6S$(Typ.)
- Low Leakage Current : $I_{GSS}=\pm100nA$(Max.) @ $V_{GS}=\pm20V$
  $I_{DSS}=1mA$(Max.) @ $V_{DS}=250V$
- Enhancement-Mode : $V_{th}=1.5\sim3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	30	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-65 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm20V$, $V_{DS}=0$	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V$, $V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA$, $V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V$, $I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$\lvert Y_{fs}\rvert$	$V_{DS}=10V$, $I_D=10A$	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=10A$, $V_{GS}=10V$	-	0.2	0.25	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A$, $V_{GS}=10V$	-	2.0	2.5	V
Input Capacitance		C_{iss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	1600	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	220	320	pF
Output Capacitance		C_{oss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	570	700	pF
Switching Time	Rise Time	t_r	 $I_D=10A$ 10V 0 10μs V_{IN} V_{OUT} 50Ω 20Ω V_{IN} : t_r, t_f <5ns V_{DD}≑200V D.U≦1% (Z_{OUT}=50Ω)	-	110	220	ns
	Turn-on Time	t_{on}		-	130	260	ns
	Fall Time	t_f		-	100	200	ns
	Turn-off Time	t_{off}		-	320	640	ns

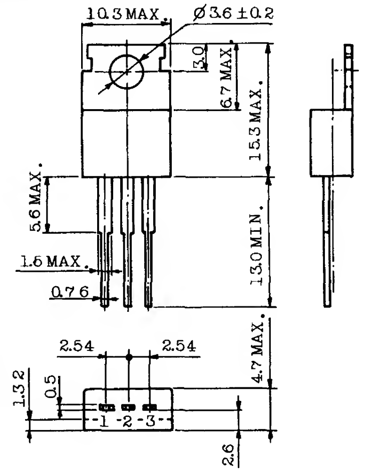
SILICON N CHANNEL MOS TYPE (π-MOS)

2SK357

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
DC-DC CONVERTER, MOTOR AND SOLENOID DRIVE APPLICATIONS.

FEATURES:
- Low Drain-Source ON Resistance : $R_{DS(ON)}$=0.6Ω (Typ.)
- High Forward Transfer Admittance: $|Y_{fs}|$=1.8S (Typ.)
- High Drain Current : I_{DP}=8A (Max.)
- Low Leakage Current: I_{GSS}=±100nA (Max.) @ V_{GS}=±20V
  I_{DSS}=1mA (Max.) @ V_{DS}=150V
- Enhancement-Mode : V_{th}=1.5 ~ 3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS
Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

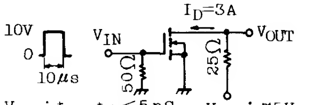
JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1C

Weight : 1.9g

MAXIMUM RATINGS (T_a=25°C)

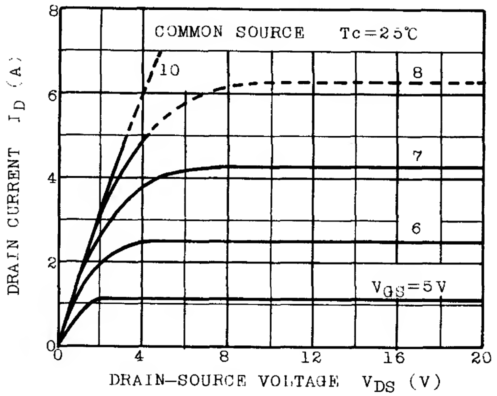
CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	150	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation (T_c=25°C)		P_D	40	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

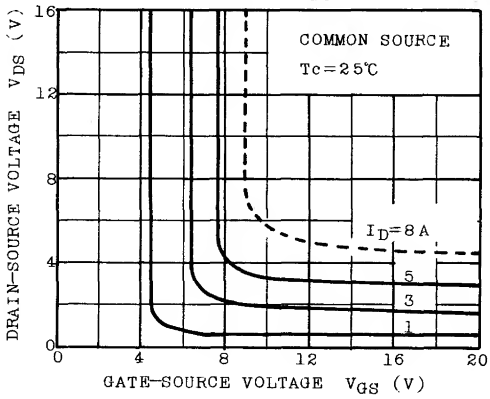
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=150V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D-10mA, V_{GS}=0	150	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=3A	0.8	1.8	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=3A, V_{GS}=10V	-	0.6	0.9	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=8A, V_{GS}=10V	-	5.5	9.5	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	260	350	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	50	100	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	160	250	pF
Switching Time	Rise Time	t_r	 I_D=3A 10V 0 10μs V_{IN} 50Ω 25Ω V_{OUT}	-	30	60	ns
	Turn-on Time	t_{on}	V_{IN}; t_r, t_f < 5ns V_{DD} ≑ 75V	-	40	80	
	Fall Time	t_f	D.U ≦ 1% (Z_{out} = 50Ω)	-	20	50	
	Turn-off Time	t_{off}		-	60	120	

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

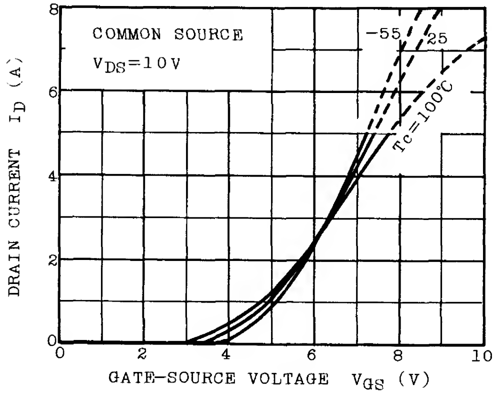
$I_D - V_{DS}$



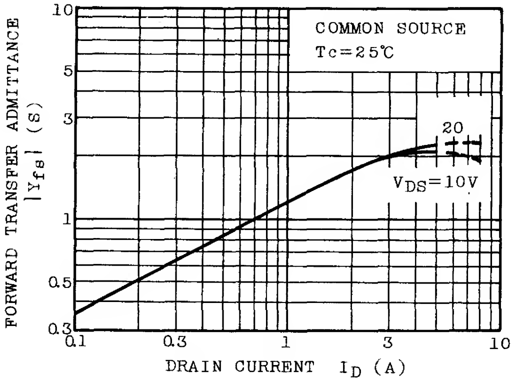
$V_{DS} - V_{GS}$



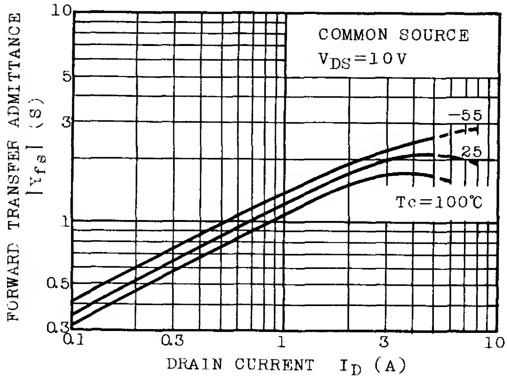
$I_D - V_{GS}$



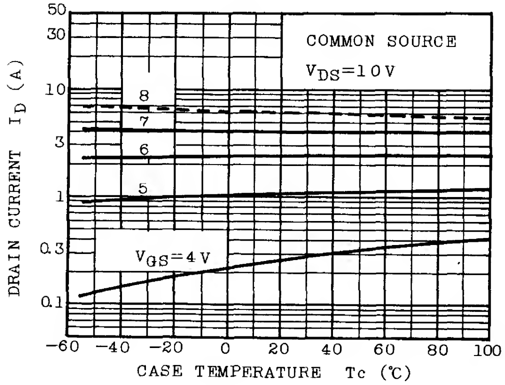
$|Y_{fs}| - I_D$



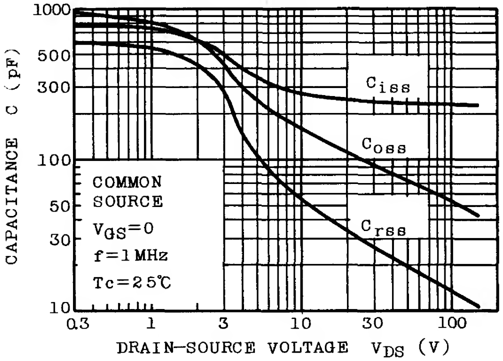
$|Y_{fs}| - I_D$



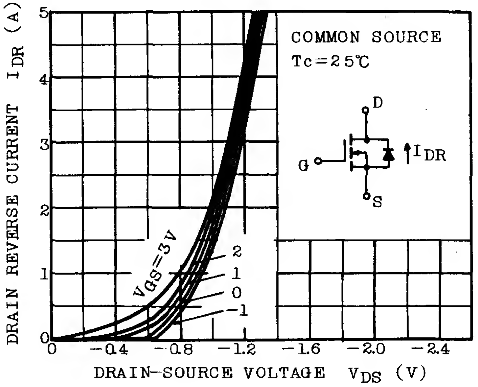
$I_D - Tc$



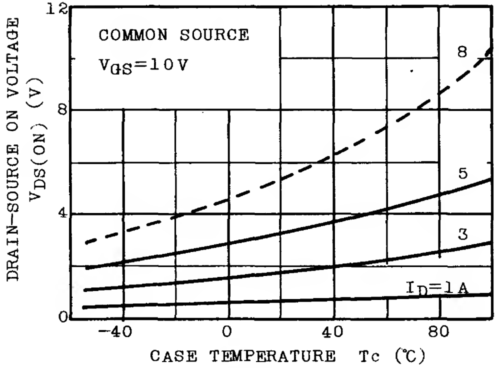
CAPACITANCE — V_{DS}



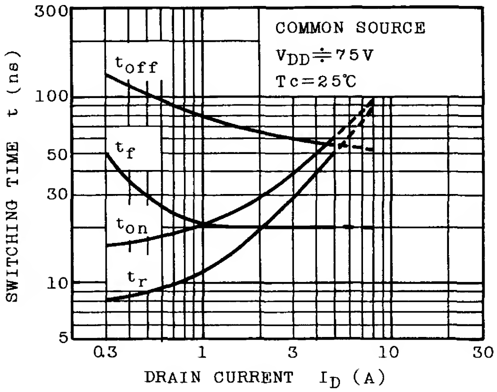
I_{DR} — V_{DS}



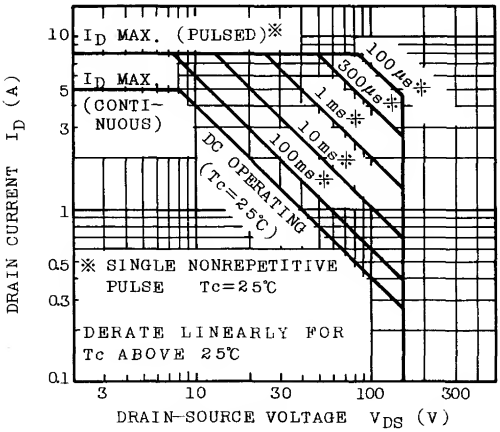
$V_{DS(ON)}$ — Tc



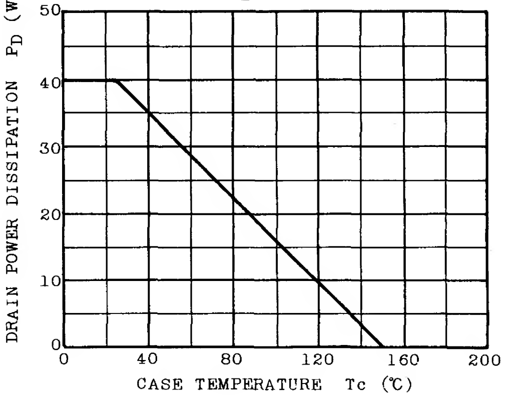
SWITCHING TIME — I_D



SAFE OPERATING AREA



P_D — Tc



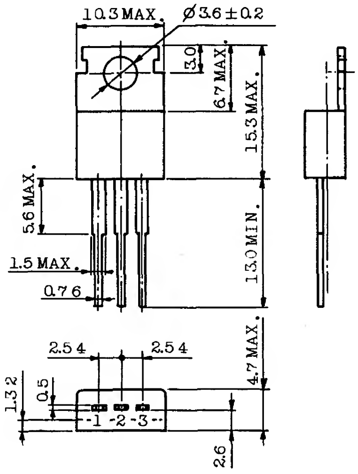
2SK358

SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

DC-DC CONVERTER, MOTOR AND SOLENOID DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1C

Weight : 1.9g

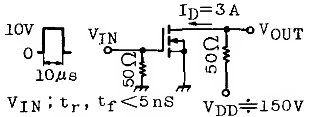
FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.7\Omega$ (Typ.)
- High Forward Transfer Admittance: $|Y_{fs}|=2.3S$ (Typ.)
- High Drain Current : $I_{DP}=8A$ (Max.)
- Low Leakage Current: $I_{GSS}=\pm100nA$ (Max.) @ $V_{GS}=\pm20V$
  $I_{DSS}=1mA$ (Max.) @ $V_{DS}=250V$
- Enhancement-Mode : $V_{th}=1.5\sim3.5V$ @ $I_D=1mA$

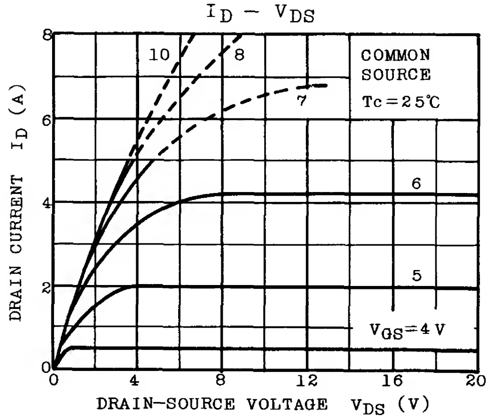
MAXIMUM RATINGS (Ta=25°C)

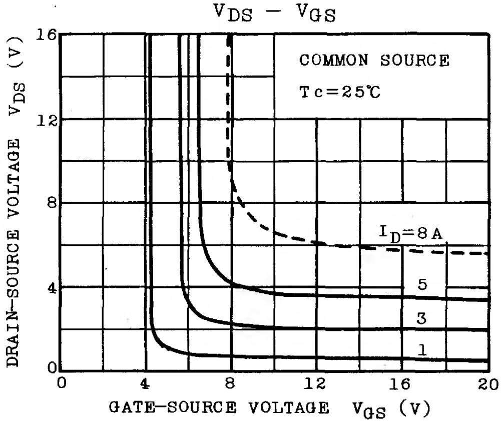
CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation (Tc=25°C)		P_D	40	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

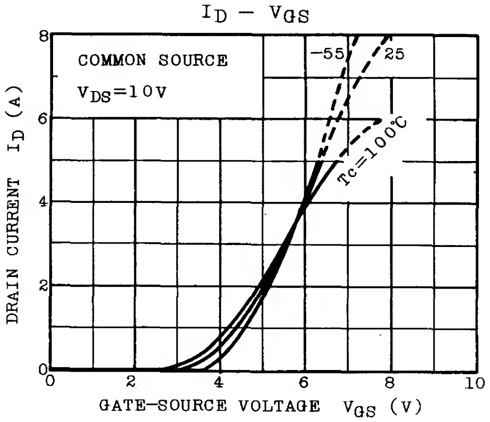
ELECTRICAL CHARACTERISTICS (Ta=25°C)

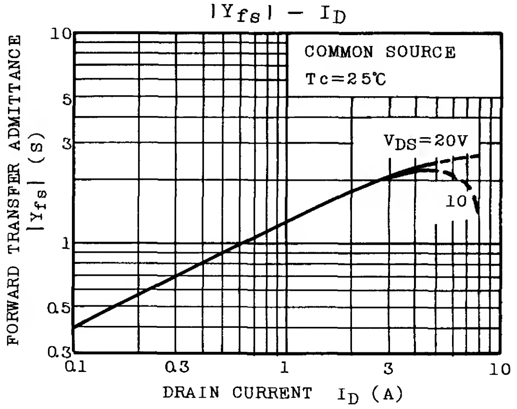
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm20V$, $V_{DS}=0$	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V$, $V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA$, $V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V$, $I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$\lvert Y_{fs}\rvert$	$V_{DS}=10V$, $I_D=3A$	1.0	2.3	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=3A$, $V_{GS}=10V$	-	0.7	1.0	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=8A$, $V_{GS}=10V$	-	6.5	12	V
Input Capacitance		C_{iss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	380	500	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	60	120	pF
Output Capacitance		C_{oss}	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	185	300	pF
Switching Time	Rise Time	t_r	 $I_D=3A$ 10V 0 10μs V_{IN} 50Ω 50Ω V_{OUT} $V_{DD}\doteqdot150V$ V_{IN}; t_r, $t_f<5nS$ D.U≦1% ($Z_{out}=50\Omega$)	-	20	40	ns
	Turn-on Time	t_{on}		-	30	60	
	Fall Time	t_f		-	30	60	
	Turn-off Time	t_{off}		-	80	160	

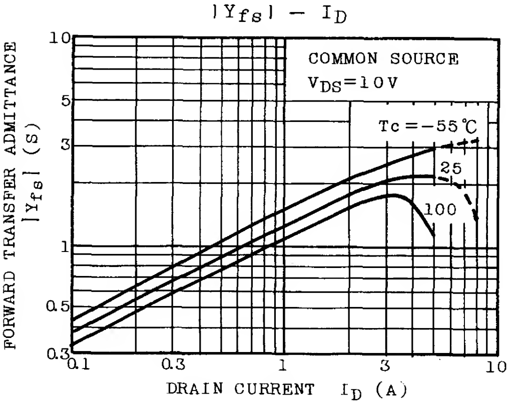
THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

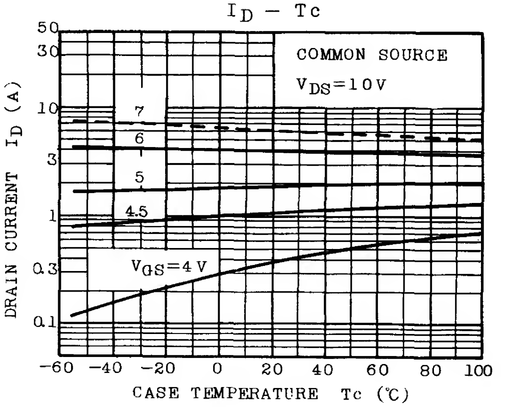

ID – VDS
COMMON SOURCE
Tc=25℃
10
8
7
6
5
VGS=4 V
DRAIN CURRENT ID (A)
0
2
4
6
8
0
4
8
12
16
20
DRAIN–SOURCE VOLTAGE VDS (V)


VDS – VGS
COMMON SOURCE
Tc=25℃
ID=8 A
5
3
1
DRAIN–SOURCE VOLTAGE VDS (V)
0
4
8
12
16
0
4
8
12
16
20
GATE–SOURCE VOLTAGE VGS (V)

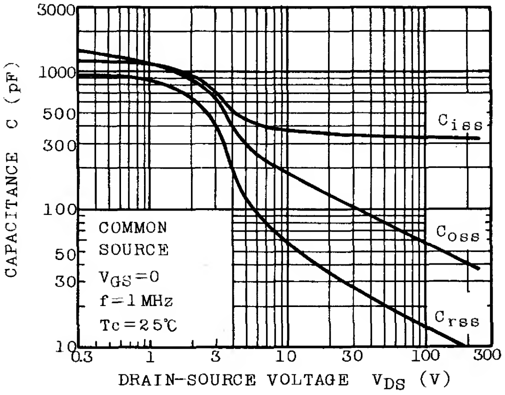

ID – VGS
COMMON SOURCE
VDS=10V
−55
25
Tc=100℃
DRAIN CURRENT ID (A)
0
2
4
6
8
0
2
4
6
8
10
GATE–SOURCE VOLTAGE VGS (V)


|Yfs| – ID
COMMON SOURCE
Tc=25℃
VDS=20V
10
FORWARD TRANSFER ADMITTANCE |Yfs| (S)
0.3
0.5
1
3
5
10
0.1
0.3
1
3
10
DRAIN CURRENT ID (A)

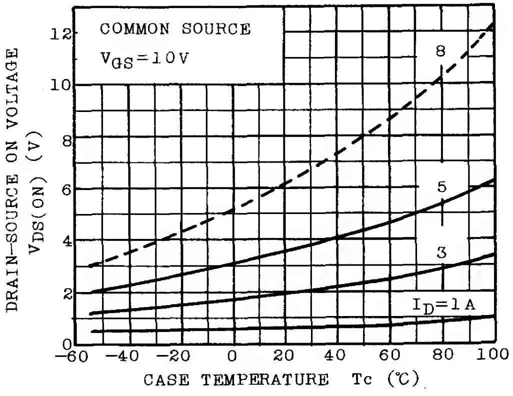

|Yfs| – ID
COMMON SOURCE
VDS=10V
Tc=−55℃
25
100
FORWARD TRANSFER ADMITTANCE |Yfs| (S)
0.3
0.5
1
3
5
10
0.1
0.3
1
3
10
DRAIN CURRENT ID (A)


ID – Tc
COMMON SOURCE
VDS=10V
7
6
5
4.5
VGS=4 V
DRAIN CURRENT ID (A)
0.1
0.3
1
3
10
30
50
−60
−40
−20
0
20
40
60
80
100
CASE TEMPERATURE Tc (℃)

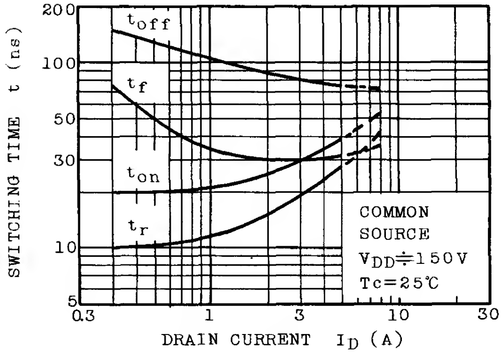
CAPACITANCE — V_{DS}



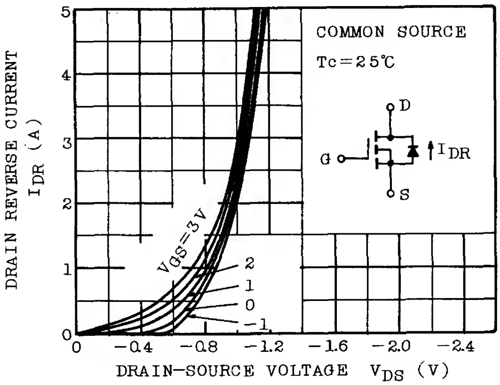
$V_{DS(ON)}$ — Tc



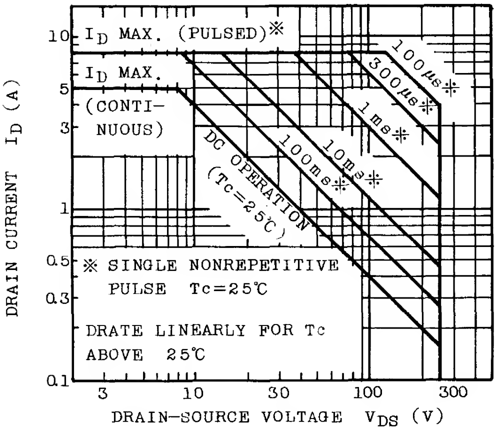
SWITCHING TIME — I_D



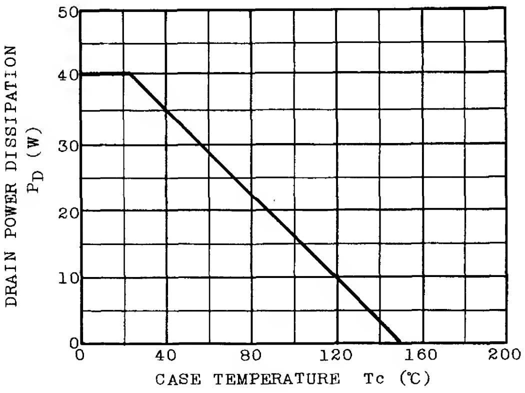
I_{DR} — V_{DS}



SAFE OPERATING AREA



P_D — Tc



SILICON N CHANNEL MOS TYPE (π-MOS)

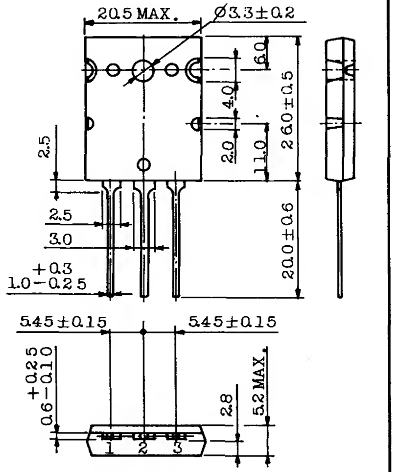
2SK385

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	−
EIAJ	−
TOSHIBA	2−21F1B

Weight : 9.7g

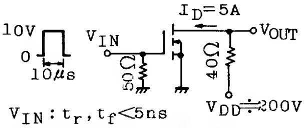
FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}$=400V
- High Forward Transfer Admittance : $|Y_{fs}|$ =5S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=400V
- Enhancement-Mode : V_{th}=1.5∼3.5V @ I_D=1mA

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		Tch	150	°C
Storage Temperature Range		Tstg	-55∼150	°C

ELECTRICAL CHARACTERISTICS Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakgae Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=400V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	400	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=5A	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=5A, V_{GS}=10V	-	0.45	0.6	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	5	7	V
Input Capacitance		Ciss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	1500	2000	pF
Reverse Transfer Capacitance		Crss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	150	300	pF
Output Capacitance		Coss	V_{DS}=10V, V_{GS}=0, f=1MHz	-	400	600	pF
Switching Time	Rise Time	t_r	 I_D=5A 10V 0 10μs V_{IN} 50Ω 40Ω V_{OUT} V_{DD}≒200V V_{IN} : t_r, t_f < 5ns D.U≦1% (Z_{OUT}=50Ω)	-	50	100	ns
	Turn-on Time	ton		-	80	150	ns
	Fall Time	tf		-	80	150	ns
	Turn-off Time	toff		-	350	700	ns

2SK386

SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

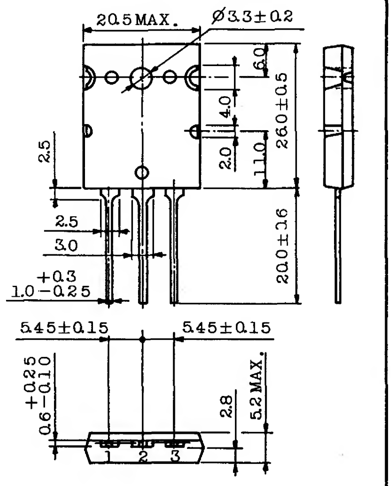
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}$=450V
- High Forward Transfer Admittance : $|Y_{fs}|$ =5S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=450V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

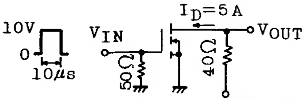
JEDEC	—
EIAJ	—
TOSHIBA	2-21F1B

Weight : 9.7g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=450V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	450	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=5A	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=5A, V_{GS}=10V	-	0.5	0.7	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	5.5	8	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	1600	2000	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	140	300	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	400	600	pF
Switching Time	Rise Time	t_r	 I_D=5A 10V 0 10μs V_{IN} V_{OUT} 50Ω 40Ω V_{IN} : t_r, t_f<5ns V_{DD}≑200V D.U≦1% (Z_{OUT}=50Ω)	-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns

SILICON N CHANNEL MOS TYPE (π-MOS)

2SK387

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

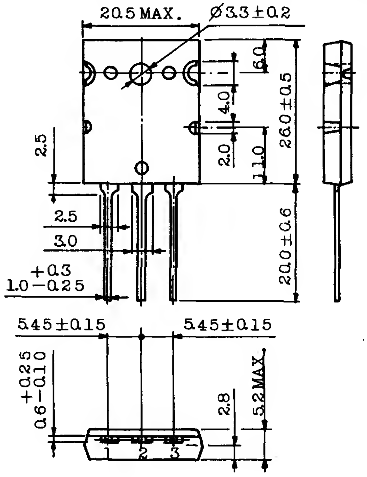
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}$=0.12Ω (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|$ =6S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=150V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

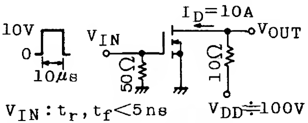
JEDEC	−
EIAJ	−
TOSHIBA	2−21F1B

Weight : 9.7g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	150	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	40	
Drain Power Dissipation (Tc=25°C)		P_D	150	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=150V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	150	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=10A	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	0.12	0.18	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	1.2	1.8	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	1600	2200	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	350	600	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	800	1300	pF
Switching Time	Rise Time	t_r	 10V 0 10μs V_{IN} I_D=10A V_{OUT} 50Ω 10Ω V_{IN} : t_r, t_f<5ns V_{DD}≑100V D.U≦1% (Z_{OUT}=50Ω)	-	120	260	ns
	Turn-on Time	t_{on}		-	150	300	ns
	Fall Time	t_f		-	120	240	ns
	Turn-off Time	t_{off}		-	300	600	ns

2SK388

SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

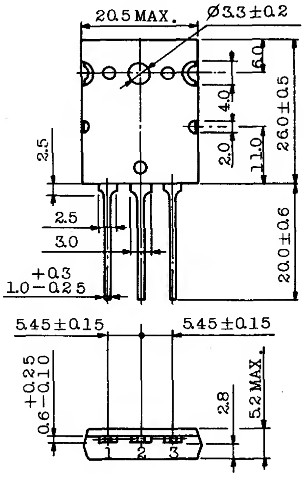
- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.2\Omega$ (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|=6S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm100nA$ (Max.) @ $V_{GS}=\pm20V$
  $I_{DSS}=1mA$ (Max.) @ $V_{DS}=250V$
- Enhancement-Mode : $V_{th}=1.5\sim3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	30	
Drain Power Dissipation (Tc=25°C)		P_D	150	W
Channel Temperature		Tch	150	°C
Storage Temperature Range		Tstg	-55~150	°C

INDUSTRIAL APPLICATIONS

Unit in mm

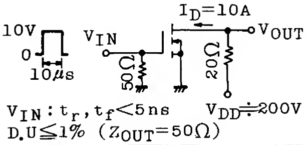


1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	―
EIAJ	―
TOSHIBA	2−21F1B

Weight : 9.7g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm20V$, $V_{DS}=0$	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V$, $V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA$, $V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V$, $I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$\lvert Y_{fs}\rvert$	$V_{DS}=10V$, $I_D=10A$	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=10A$, $V_{GS}=10V$	-	0.20	0.25	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A$, $V_{GS}=10V$	-	2.0	2.5	V
Input Capacitance		Ciss	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	1600	2000	pF
Reverse Transfer Capacitance		Crss	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	220	320	pF
Output Capacitance		Coss	$V_{DS}=10V$, $V_{GS}=0$, f=1MHz	-	570	700	pF
Switching Time	Rise Time	t_r	 $I_D=10A$ 10V 0 10μs V_{IN} V_{OUT} 50Ω 20Ω V_{IN} : t_r, t_f<5ns $V_{DD}\doteqdot200V$ D.U≦1% ($Z_{OUT}=50\Omega$)	-	110	220	ns
	Turn-on Time	ton		-	130	260	ns
	Fall Time	t_f		-	100	200	ns
	Turn-off Time	toff		-	320	640	ns

SILICON N CHANNEL MOS TYPE (π-MOS)

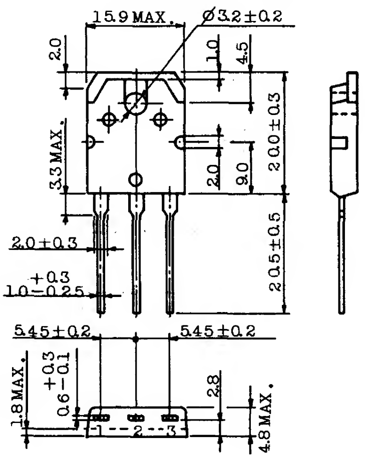
2SK405

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

FEATURES:

- High Breakdown Voltage : V_{DSS}=160V
- High Forward Transfoer Admittance : $|Y_{fs}|$=2.0S (Typ.)
- Complementary to 2SJ115

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	–
EIAJ	–
TOSHIBA	2-16C1B

Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

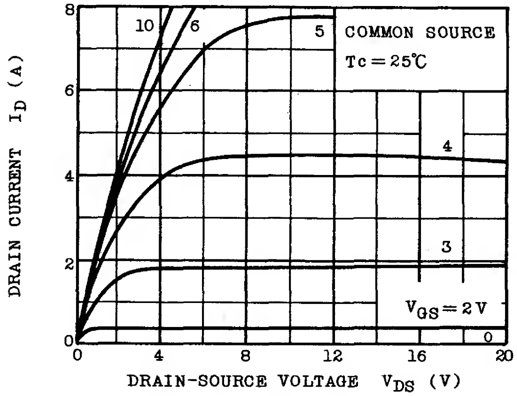
CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSS}	160	V
Gate-Source Voltage	V_{GSS}	±20	V
Drain Current	I_D	8	A
Power Dissipation (Tc=25°C)	P_D	100	W
Channel Temperature	T_{ch}	150	°C
Storage Temperature Range	T_{stg}	-55 ~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

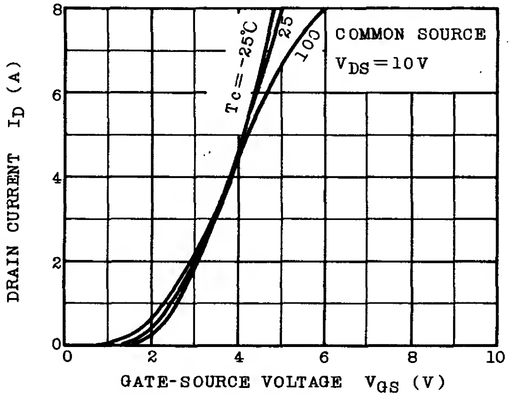
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I_{GSS}	V_{DS}=0, V_{GS}=±20V	-	-	±1.0	μA
Drain-Source Breakdwon Voltage	$V_{(BR)DSS}$	I_D=5mA, V_{GS}=0	160	-	-	V
Gate-Source Cut-off Voltage	$V_{GS(OFF)}$ (Note)	V_{DS}=10V, I_D=0.1A	0.8	-	2.8	V
Drain-Source Saturation Voltage	$V_{DS(ON)}$	I_D=5A, V_{GS}=10V	-	2.5	7.0	V
Forward Transfer Admittance	$\|Y_{fs}\|$	V_{DS}=10V, I_D=2A	1.0	2.0	-	S
Input Capacitance	C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	430	-	pF
Output Capacitance	C_{oss}	V_{DS}=10V,V_{GS}=0,f=1MHz	-	260	-	pF
Reverse Transfer Capacitance	C_{rs}	V_{DS}=10V,V_{GS}=0,f=1MHz	-	80	-	pF

Note : $V_{GS(OFF)}$ Classification O : 0.8~1.6, Y : 1.4~2.8

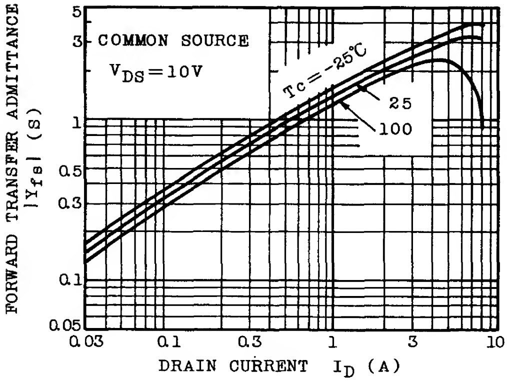
$I_D - V_{DS}$



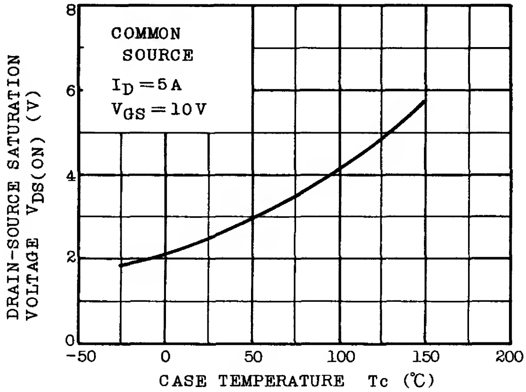
$I_D - V_{GS}$



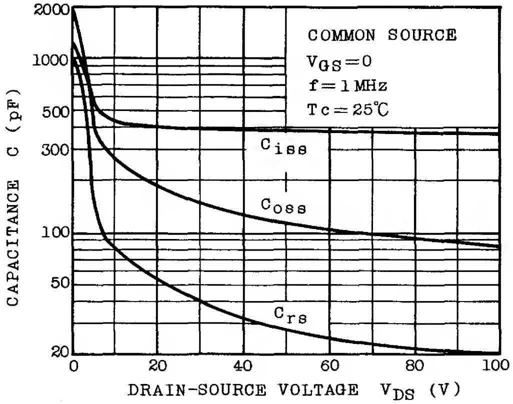
$|Y_{fs}| - I_D$



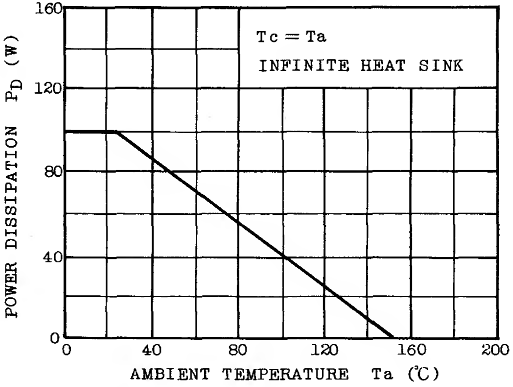
$V_{DS(ON)} - T_c$

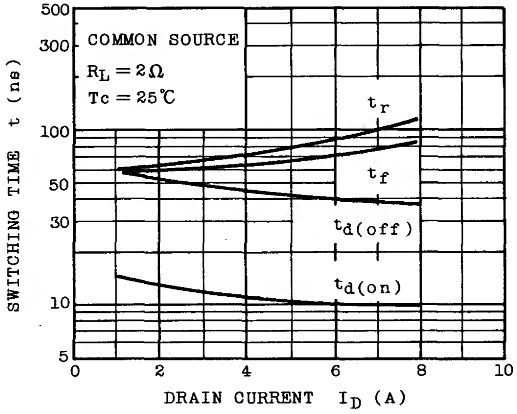


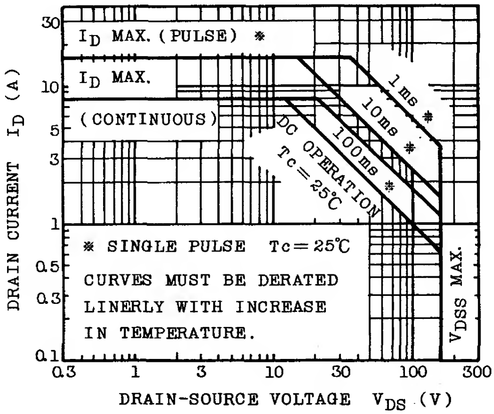
$C - V_{DS}$

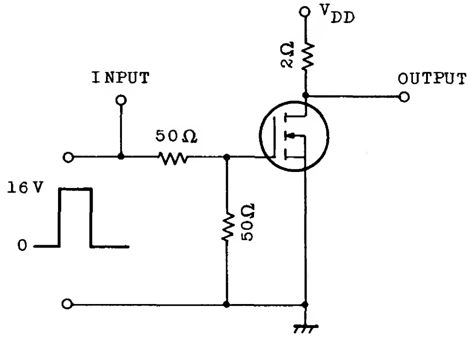


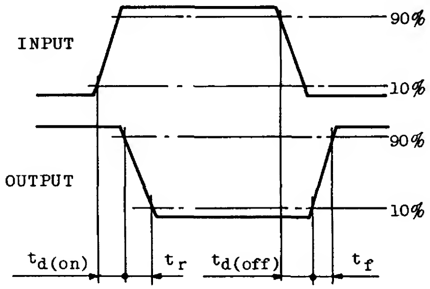
$P_D - T_a$




t – I_D


SAFE OPERATING AREA





2SK417

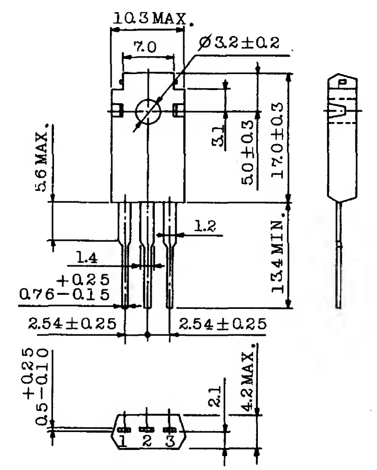
SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

JEDEC	–
EIAJ	–
TOSHIBA	2-10K1B

Weight : 2.0g

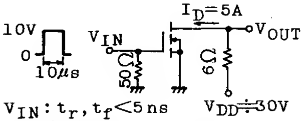
FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}$=0.1Ω (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|$=4S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=60V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	60	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	60	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=60V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdwon Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	60	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		Y_{fs}	V_{DS}=10V, I_D=5A	2	4	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=5A, V_{GS}=10V	-	0.10	0.14	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=10A, V_{GS}=10V	-	1.0	1.5	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	850	1100	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	370	600	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	800	1100	pF
Switching Time	Rise Time	t_r	 I_D=5A 10V 0 10μs V_{IN} V_{OUT} 50Ω 6Ω V_{DD}≒30V V_{IN}: t_r, t_f<5ns D.U≦1% (Z_{OUT}=50Ω)	-	100	200	ns
	Turn-on Time	t_{on}		-	120	240	ns
	Fall Time	t_f		-	85	170	ns
	Turn-off Time	t_{off}		-	160	320	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

SILICON N CHANNEL MOS TYPE (π-MOS)

2SK418

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

. High Breakdown Voltage : $V_{(BR)DSS}$=400V

. High Forward Transfer Admittance : $|Y_{fs}|$=1.2S (Typ.)

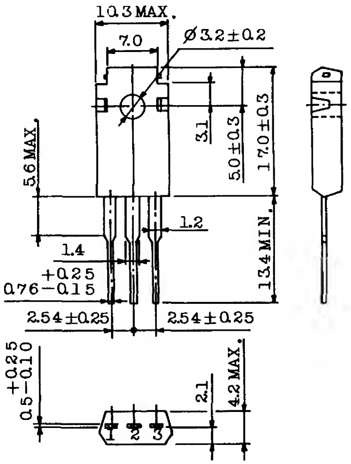
. Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V

I_{DSS}=1mA(Max.) @ V_{DS}=400V

. Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

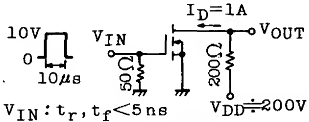
JEDEC	–
EIAJ	–
TOSHIBA	2-10K1B

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	2	A
	Pulse	I_{DP}	4	
Drain Power Dissipation (Tc=25°C)		P_D	50	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=400V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	400	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=1A	0.6	1.2	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=1A, V_{GS}=10V	-	1.6	2.2	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=4A, V_{GS}=10V	-	8.5	12	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	410	600	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	35	70	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	115	170	pF
Switching Time	Rise Time	t_r	 I_D=1A 10V 0 10μs V_{IN} V_{OUT} 50Ω 200Ω V_{DD}≑200V V_{IN} : t_r, t_f<5ns D.U≦1% (Z_{OUT}=50Ω)	-	15	30	ns
	Turn-on Time	t_{on}		-	30	60	ns
	Fall Time	t_f		-	30	60	ns
	Turn-off Time	t_{off}		-	100	200	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

2SK419

SILICON N CHANNEL MOS TYPE (π-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

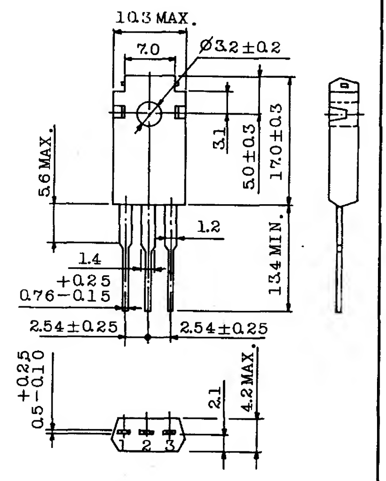
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- High Brakdwon Voltage : $V_{(BR)DSS}=450V$
- High Forward Transfer Admittance : $|Y_{fs}|=1.2S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm100nA$ (Max.) @ $V_{GS}=\pm20V$
  $I_{DSS}=1mA$ (Max.) @ $V_{DS}=450V$
- Enhancement-Mode : $V_{th}=1.5\sim3.5V$ @ $I_D=1mA$

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

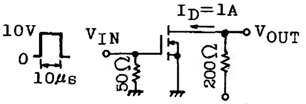
JEDEC	–
EIAJ	–
TOSHIBA	2–10K1B

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	2	A
	Pulse	I_{DP}	4	
Drain Power Dissipation (Tc=25°C)		P_D	50	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm20V,\ V_{DS}=0$	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=450V,\ V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA,\ V_{GS}=0$	450	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V,\ I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	$V_{DS}=10V,\ I_D=1A$	0.6	1.2	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=1A,\ V_{GS}=10V$	-	1.8	2.5	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=4A,\ V_{GS}=10V$	-	9.0	14	V
Input Capacitance		C_{iss}	$V_{DS}=10V,\ V_{GS}=0,\ f=1MHz$	-	410	600	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V,\ V_{GS}=0,\ f=1MHz$	-	35	70	pF
Output Capacitance		C_{oss}	$V_{DS}=10V,\ V_{GS}=0,\ f=1MHz$	-	115	170	pF
Switching Time	Rise Time	t_r	 $I_D=1A$ 10V 0 10μs V_{IN} 50Ω 200Ω V_{OUT} $V_{IN}: t_r, t_f<5ns$ $V_{DD}\doteqdot200V$ D.U≦1% ($Z_{OUT}=50\Omega$)	-	15	30	ns
	Turn-on Time	t_{on}		-	30	60	ns
	Fall Time	t_f		-	30	60	ns
	Turn-off Time	t_{off}		-	100	200	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

SILICON N CHANNEL MOS TYPE (π-MOS)

2SK420

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

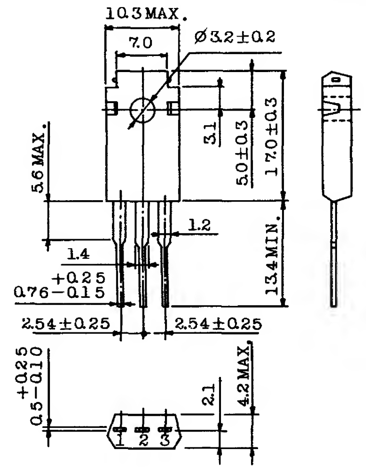
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}$=400V
- High Forward Transfer Admittance : $|Y_{fs}|$=2.5S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=400V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS

Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

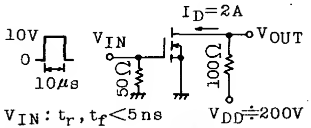
JEDEC	–
EIAJ	–
TOSHIBA	2–10K1B

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation (Tc=25°C)		P_D	60	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	–	–	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=400V, V_{GS}=0	–	–	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	400	–	–	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	–	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=3A	1.0	2.5	–	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=3A, V_{GS}=10V	–	1.0	1.4	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=8A, V_{GS}=10V	–	10	18	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	–	670	900	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	–	50	90	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	–	180	250	pF
Switching Time	Rise Time	t_r	 I_D=2A 10V 0 10μs V_{IN} V_{OUT} 50Ω 100Ω V_{DD}≒200V V_{IN} : t_r, t_f<5ns D.U≦1% (Z_{OUT}=50Ω)	–	25	50	ns
	Turn-on Time	t_{on}		–	40	80	ns
	Fall Time	t_f		–	35	70	ns
	Turn-off Time	t_{off}		–	140	280	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

2SK421

SILICON N CHANNEL MOS TYPE (π-MOS)

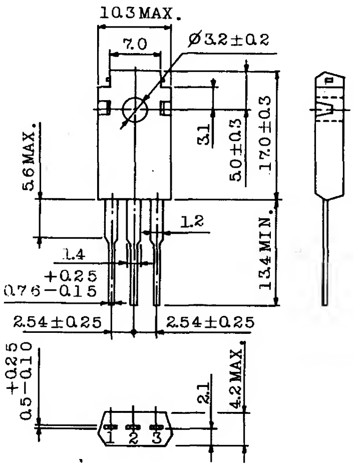
HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}$=450V
- High Forward Transfer Admittance : $|Y_{fs}|$=2.5S (Typ.)
- Low Leakage Current : I_{GSS}=±100nA(Max.) @ V_{GS}=±20V
  I_{DSS}=1mA(Max.) @ V_{DS}=450V
- Enhancement-Mode : V_{th}=1.5～3.5V @ I_D=1mA

INDUSTRIAL APPLICATIONS
Unit in mm



1. GATE
2. DRAIN (HEAT SINK)
3. SOURCE

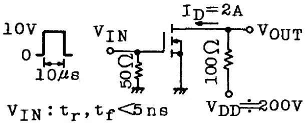
JEDEC	−
EIAJ	−
TOSHIBA	2−10K1B

Weight : 2.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation (Tc=25°C)		P_D	60	W
Channel Temperature		Tch	150	°C
Storage Temperature Range		Tstg	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	V_{GS}=±20V, V_{DS}=0	-	-	±100	nA
Drain Cut-off Current		I_{DSS}	V_{DS}=450V, V_{GS}=0	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	I_D=10mA, V_{GS}=0	450	-	-	V
Gate Threshold Voltage		V_{th}	V_{DS}=10V, I_D=1mA	1.5	-	3.5	V
Forward Transfer Admittance		$\|Y_{fs}\|$	V_{DS}=10V, I_D=3A	1.0	2.5	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	I_D=3A, V_{GS}=10V	-	1.1	1.6	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	I_D=8A, V_{GS}=10V	-	12	22	V
Input Capacitance		C_{iss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	670	900	pF
Reverse Transfer Capacitance		C_{rss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	50	90	pF
Output Capacitance		C_{oss}	V_{DS}=10V, V_{GS}=0, f=1MHz	-	180	250	pF
Switching Time	Rise Time	t_r	 10V 0 10μs V_{IN} 50Ω I_D=2A V_{OUT} 100Ω V_{DD}≒200V V_{IN} : t_r, t_f < 5ns D.U≦1% (Z_{OUT}=50Ω)	-	25	50	ns
	Turn-on Time	t_{on}		-	40	80	ns
	Fall Time	t_f		-	35	70	ns
	Turn-off Time	t_{off}		-	140	280	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

2N
SERIES

SILICON NPN TRIPLE DIFFUSED TYPE

2N3055

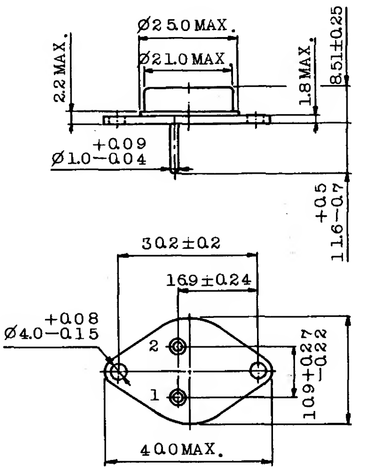
GENERAL PURPOSE POWER TRANSISTOR.

POWER REGULATOR, SWITCHING AND SOLLENOID DRIVES APPLICATIONS.

FEATURES:

. High Gain at High Current
. Low Saturation Voltage : $V_{CE(sat)} < 1.1V$, $@I_C=4A, I_B=0.4A$
. Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^\circ C$)

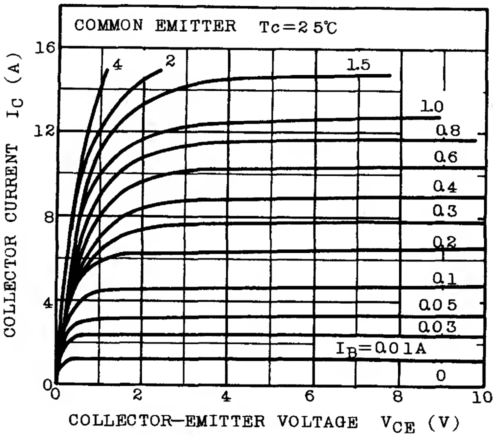
CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collcetor-Base Voltage	V_{CBO}	100	V
* Collector-Emitter Sustaining Voltage ($R_{BE}=100\,\Omega$)	$V_{CER(SUS)}$	70	V
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	60	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	15	A
* Base Current	I_B	7	A
* Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly	P_C	115	W
		0.66	W / °C
* Junction Temperature	T_j	200	°C
* Storage Temperature Range	T_{stg}	−65 ~ 200	°C

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

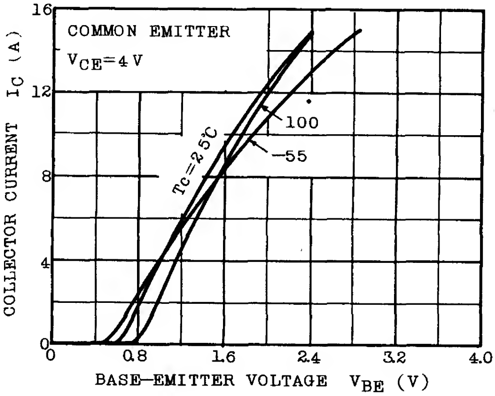
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V$, $V_{BE}=-1.5V$	-	-	5	mA
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V, V_{BE}=-1.5V, T_c=150^\circ C$	-	-	30	mA
* Collector Cut-off Current	I_{CEO}	$V_{CE}=30V$, $I_B=0$	-	-	0.7	mA
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	5	mA
* Collector-Emitter Sustaining Voltage	$V_{CER(SUS)}$ **	$I_C=0.2A$, $R_{BE}=100\,\Omega$	70	-	-	V
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$ **	$I_C=0.2A$, $I_B=0$	60	-	-	V
* DC Current Gain	h_{FE}	$V_{CE}=4V$, $I_C=4A$	20	-	70	
		$V_{CE}=4V$, $I_C=10A$	5	-	-	
* Base-Emitter Voltage	V_{BE}	$V_{CE}=4V$, $I_C=4A$	-	-	1.8	V
* Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A$, $I_B=0.4A$	-	-	1.1	V
		$I_C=10A$, $I_B=3.3A$	-	-	8	V
* Small Signal Current Gain Cut-off Frequency	f_{hfe}	$V_{CE}=4V$, $I_C=1A$, $f=10kHz$	20	-	-	kHz
* Small Signal Current Gain	$\vert h_{fe}\vert$	$V_{CE}=4V$, $I_C=1A$, $f=1MHz$	2.5	-	-	
* Second Breakdown Collector Current (Base Forward Bias)	$I_{s/b}$	$V_{CE}=40V$, $t=1s$ (non repetitive)	2.87	-	-	A

* In Accordance With JEDEC Registration Data.
** The sustaining voltages $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

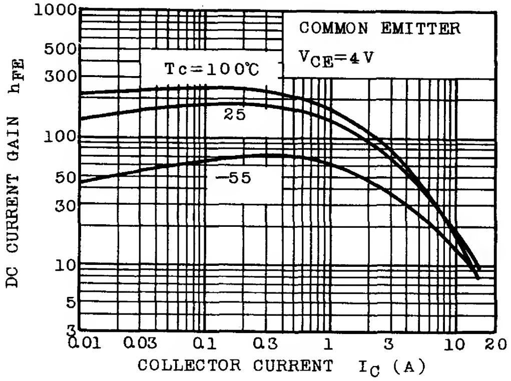
$I_C - V_{CE}$



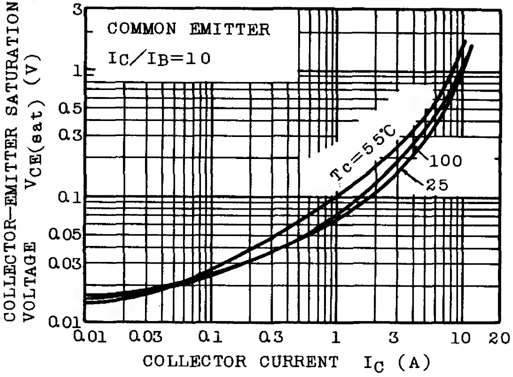
$I_C - V_{BE}$



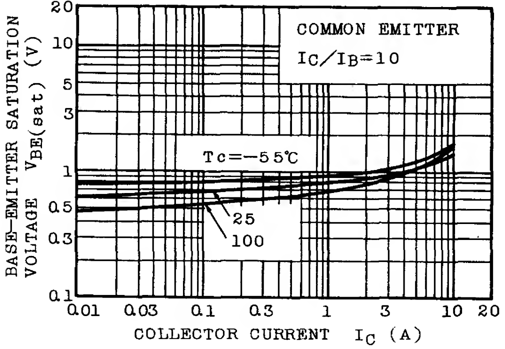
$h_{FE} - I_C$



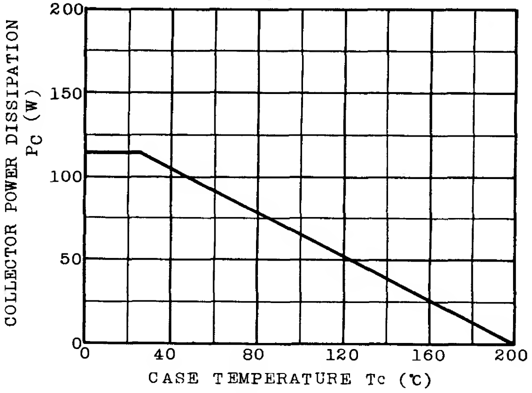
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - T_c$



SILICON NPN TRIPLE DIFFUSED TYPE

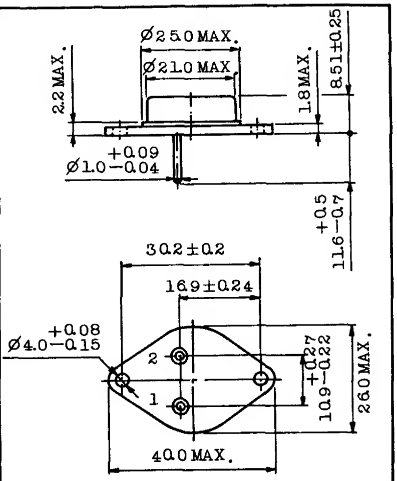
2N3713

GENERAL PURPOSE POWER TRANSISTOR.
POWER REGULATOR, SWITCHING AND SOLENOID DRIVES APPLICATIONS.

FEATURES:

- High Gain at High Current
- Low Saturation Voltage : $V_{CE(sat)}$=1.0V (Max.) @ I_C=5A, I_B=0.5A
- Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

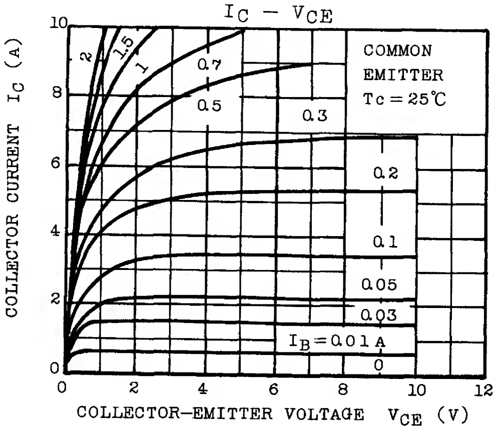
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	80	V
* Collector-Emitter Voltage	V_{CEO}	60	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation (Tc=25°C)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	°C/W
* Junction Temperature	T_j	200	°C
* Storage Temperature Range	T_{stg}	-65 ~ 200	°C

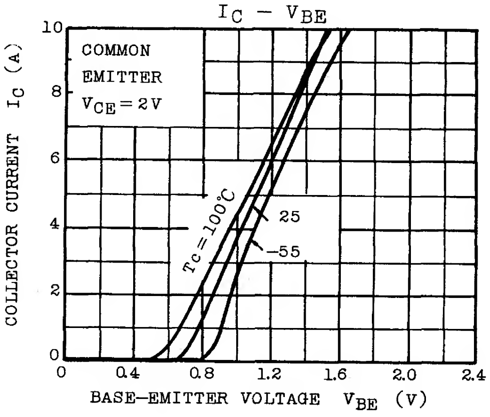
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	V_{CE}=80V, V_{BE}=-1.5V	-	-	1	mA
* Collector Cut-off Current		I_{CEX}	V_{CE}=60V, V_{BE}=-1.5V Tc=150°C	-	-	10	mA
* Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	5	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=200mA, I_B=0	60	-	-	V
* DC Current Gain		h_{FE}	V_{CE}=2V, I_C=1A	25	-	90	
			V_{CE}=2V, I_C=3A	15	-	-	
* Base-Emitter Voltage		V_{BE}	V_{CE}=2V, I_C=3A	-	-	1.5	V
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	2.0	V
Small Signal Forward Current Transfer Ratio		$\lvert h_{fe} \rvert$	V_{CE}=10V, I_C=0.5A f=1MHz	4	-	-	

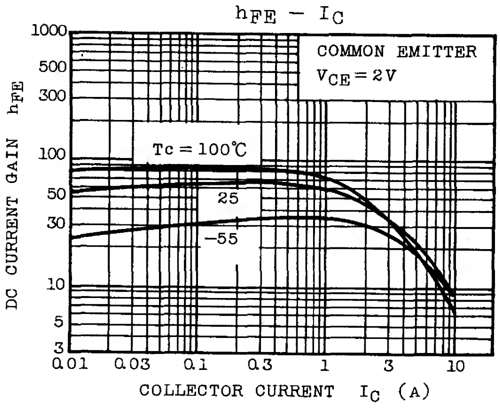
* In accordance with JEDEC registration data.
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



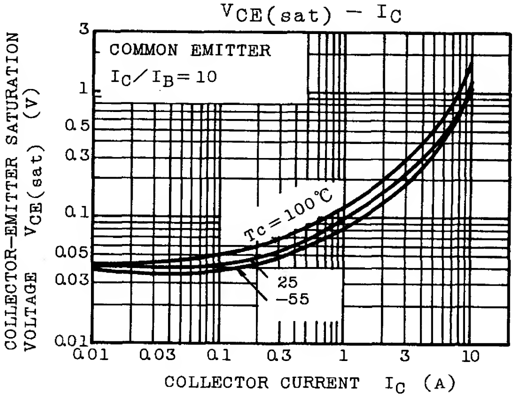
$I_C - V_{CE}$



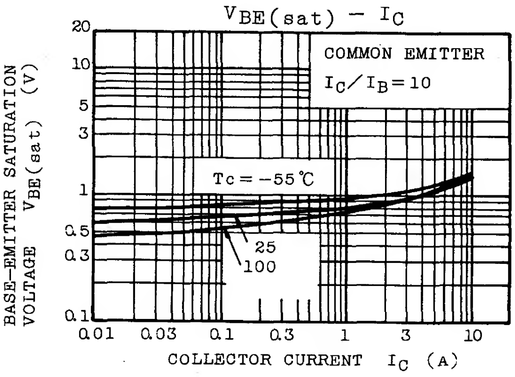
$I_C - V_{BE}$



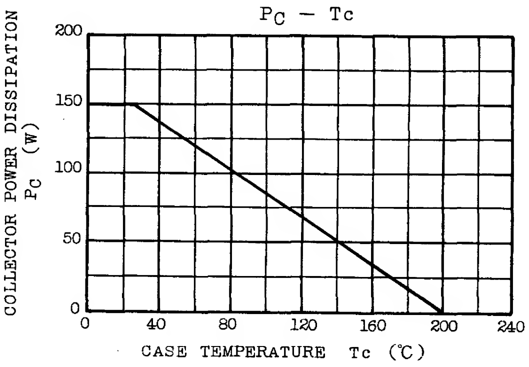
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Tc$

SILICON NPN TRIPLE DIFFUSED TYPE

2N3714

GENERAL PURPOSE POWER TRANSISTOR.
POWER REGULATOR, SWITCHING AND SOLENOID DRIVES APPLICATIONS.

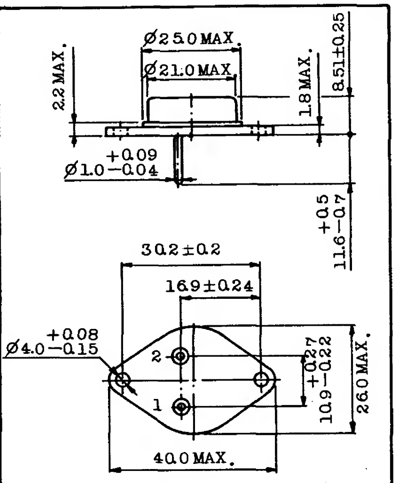
FEATURES:

. High Gain at High Current

. Low Saturation Voltage: $V_{CE(sat)}=1.0V$ (Max.)
@ $I_C=5A$, $I_B=0.5A$

. Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

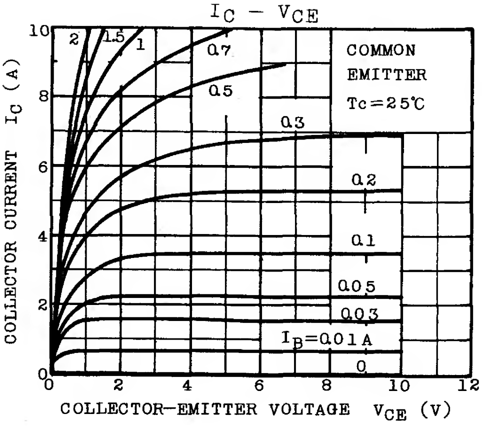
	CHARACTERISTIC	SYMBOL	RATING	UNIT
*	Collector-Base Voltage	V_{CBO}	100	V
*	Collector-Emitter Voltage	V_{CEO}	80	V
*	Emitter-Base Voltage	V_{EBO}	7	V
*	Collector Current	I_C	10	A
*	Base Current	I_B	4	A
*	Collector Power Dissipation (Tc=25°C)	P_C	150	W
*	Thermal Resistance	θ_{jc}	1.17	°C/W
*	Junction Temperature	T_j	200	°C
*	Storage Temperature Range	T_{stg}	-65 ~ 200	°C

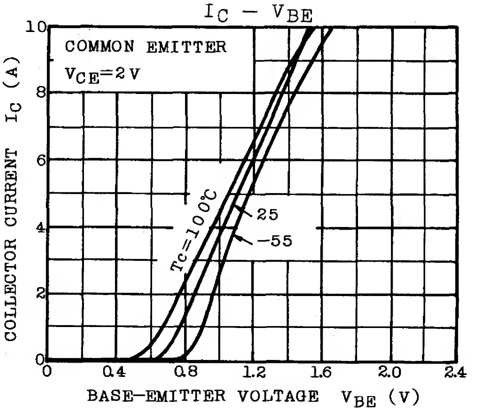
ELECTRICAL CHARACTERISTICS (Ta=25°C)

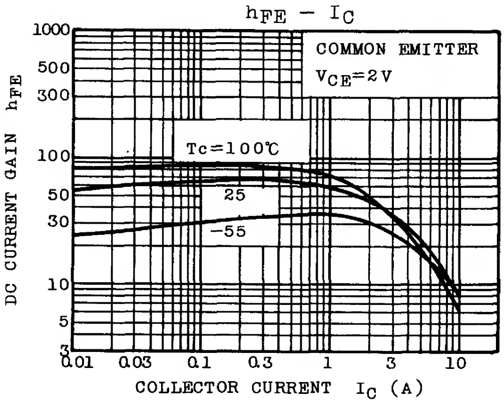
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEX}	$V_{CE}=100V$, $V_{BE}=-1.5V$	−	−	1	mA
*	Collector Cut-off Current		I_{CEX}	$V_{CE}=80V$, $V_{BE}=-1.5V$ Tc=150°C	−	−	10	mA
*	Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	−	−	5	mA
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=200mA$, $I_B=0$	80	−	−	V
*	DC Current Gain		h_{FE}	$V_{CE}=2V$, $I_C=1A$	25	−	90	
				$V_{CE}=2V$, $I_C=3A$	15	−	−	
*	Base-Emitter Voltage		V_{BE}	$V_{CE}=2V$, $I_C=3A$	−	−	1.5	V
*	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A$, $I_B=0.5A$	−	−	1.0	V
		Base-Emitter	$V_{BE(sat)}$	$I_C=5A$, $I_B=0.5A$	−	−	2.0	V
	Small Signal Forward Current Transfer Ratio		$\lvert h_{fe}\rvert$	$V_{CE}=10V$, $I_C=0.5A$ f=1MHz	4	−	−	

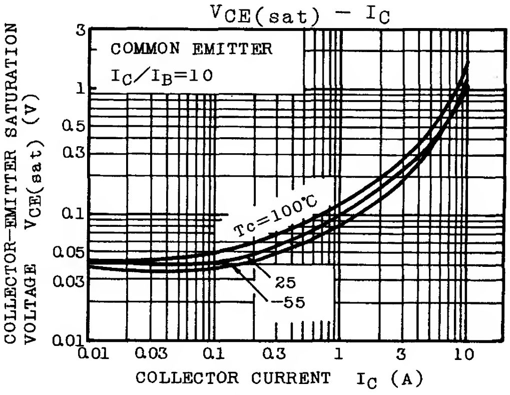
* In accordance with JEDEC registration data.

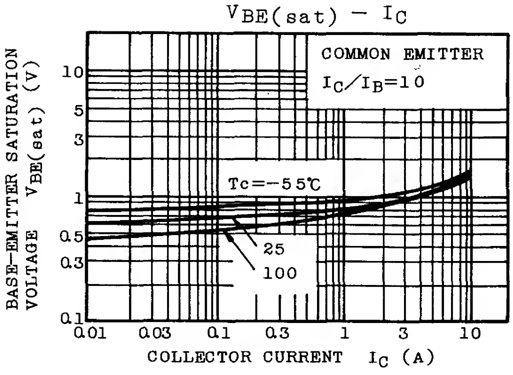
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

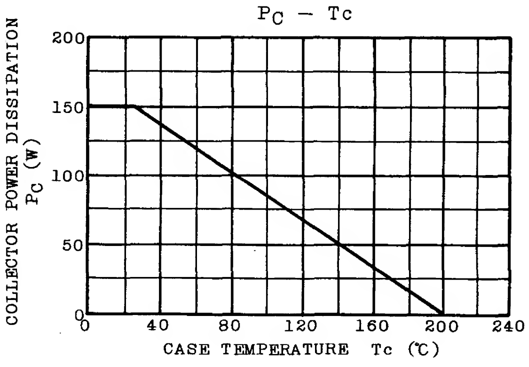

I_C – V_{CE}
COMMON EMITTER
Tc=25℃
2
1.5
1
0.7
0.5
0.3
0.2
0.1
0.05
0.03
I_B=0.01 A
0
COLLECTOR CURRENT I_C (A)
10
8
6
4
2
0
0
2
4
6
8
10
12
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)


I_C – V_{BE}
COMMON EMITTER
V_{CE}=2 V
Tc=100℃
25
–55
COLLECTOR CURRENT I_C (A)
10
8
6
4
2
0
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE–EMITTER VOLTAGE V_{BE} (V)


h_{FE} – I_C
COMMON EMITTER
V_{CE}=2 V
Tc=100℃
25
–55
DC CURRENT GAIN h_{FE}
1000
500
300
100
50
30
10
5
3
0.01
0.03
0.1
0.3
1
3
10
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B=10
Tc=100℃
25
–55
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.01
0.03
0.1
0.3
1
3
10
COLLECTOR CURRENT I_C (A)


$V_{BE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B=10
Tc=–55℃
25
100
BASE–EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
10
5
3
1
0.5
0.3
0.1
0.01
0.03
0.1
0.3
1
3
10
COLLECTOR CURRENT I_C (A)


P_C – Tc
COLLECTOR POWER DISSIPATION P_C (W)
200
150
100
50
0
0
40
80
120
160
200
240
CASE TEMPERATURE Tc (℃)

SILICON NPN TRIPLE DIFFUSED TYPE

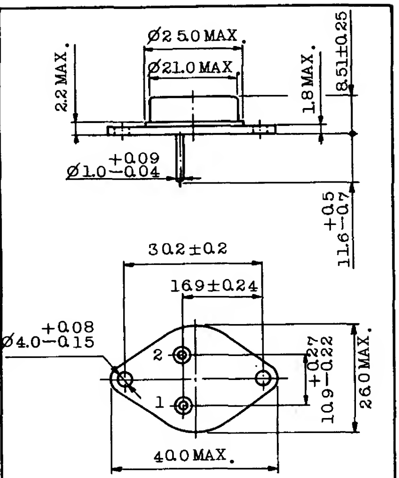
2N3715

GENERAL PURPOSE POWER TRANSISTOR.
POWER REGULATOR, SWITCHING AND SOLENOID DRIVES APPLICATIONS.

FEATURES:

- High Gain at High Current
- Low Saturation Voltage : $V_{CE(sat)}$=0.8V (Max.) @ I_C=5A, I_B=0.5A
- Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3 , TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

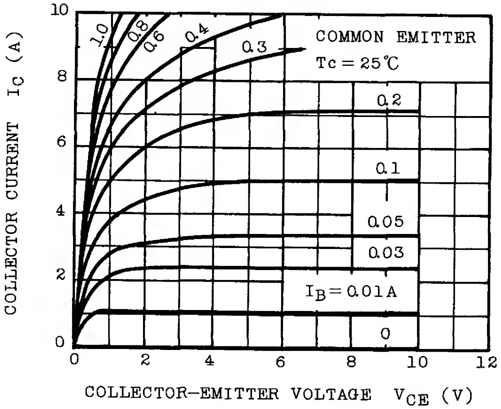
MAXIMUM RATINGS (Ta=25°C)

	CHARACTERISTIC	SYMBOL	RATING	UNIT
*	Collector-Base Voltage	V_{CBO}	80	V
*	Collector-Emitter Voltage	V_{CEO}	60	V
*	Emitter-Base Voltage	V_{EBO}	7	V
*	Collector Current	I_C	10	A
*	Base Current	I_B	4	A
*	Collector Power Dissipation (Tc=25°C)	P_C	150	W
*	Thermal Resistance	θjc	1.17	°C/W
*	Junction Temperature	T_j	200	°C
*	Storage Temperature Range	T_{stg}	-65～200	°C

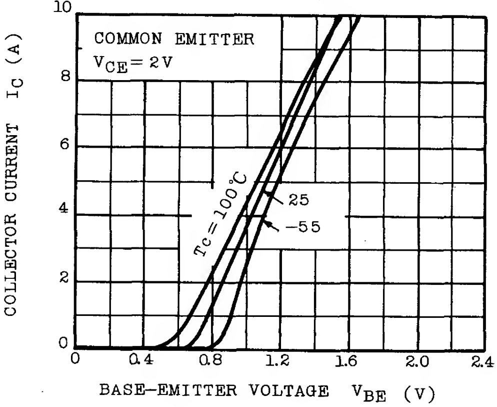
ELECTRICAL CHARACTERISTICS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEX}	V_{CE}=80V, V_{BE}=−1.5V	-	-	1	mA
*	Collector Cut-off Current		I_{CEX}	V_{CE}=60V, V_{BE}=−1.5V Tc=150°C	-	-	10	mA
*	Emitter Cut-off Current		I_{EBO}	V_{EB}=7V, I_C=0	-	-	5	mA
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$**	I_C=200mA, I_B=0	60	-	-	V
*	DC Current Gain		h_{FE}	V_{CE}=2V, I_C=1A	50	-	150	
				V_{CE}=2V, I_C=3A	30	-	-	
*	Base-Emitter Voltage		V_{BE}	V_{CE}=2V, I_C=3A	-	-	1.5	V
	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=5A, I_B=0.5A	-	-	0.8	V
		Base-Emitter	$V_{BE(sat)}$	I_C=5A, I_B=0.5A	-	-	1.5	V
	Small Signal Forward Current Transfer Ratio		$\lvert h_{fe} \rvert$	V_{CE}=10V, I_C=0.5A f=1MHz	4	-	-	

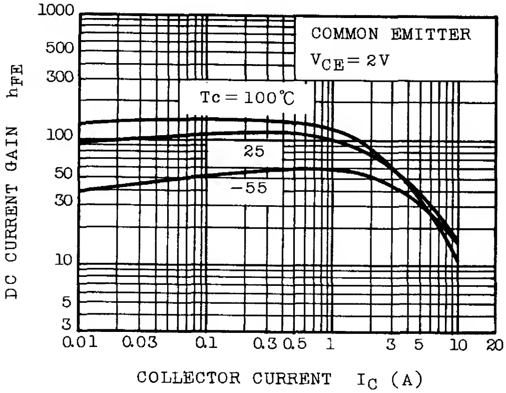
* In accordance with JEDEC registration data.
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



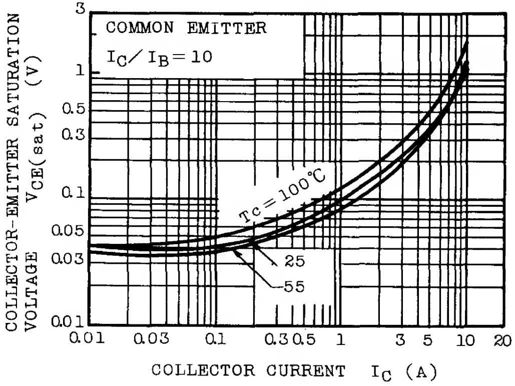
$I_C - V_{CE}$



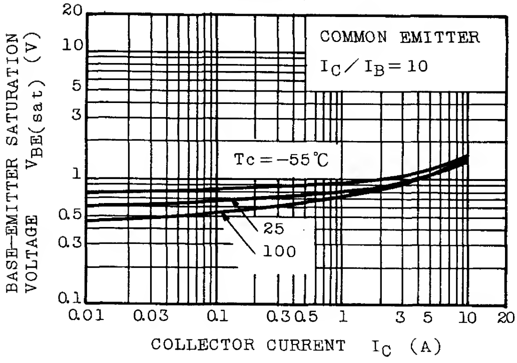
$I_C - V_{BE}$



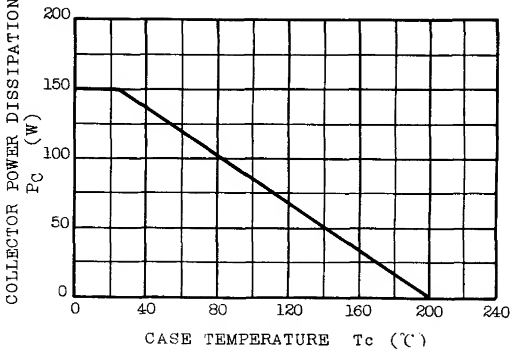
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Tc$

SILICON NPN TRIPLE DIFFUSED TYPE

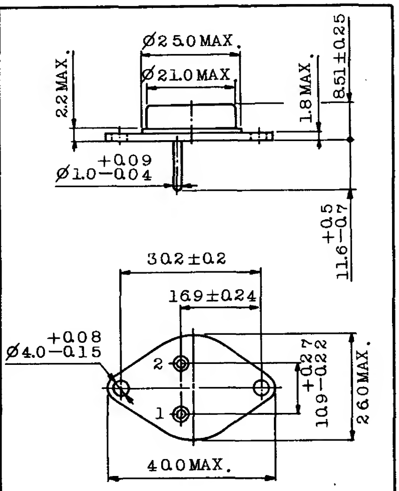
2N3716

GENERAL PURPOSE POWER TRANSISTOR.
POWER REGULATOR, SWITCHING AND SOLENOID DRIVE APPLICATIONS.

FEATURES:

- High Gain at High Current
- Low Saturation Voltage : $V_{CE(sat)}=0.8V$ @ $I_C=5A$, $I_B=0.5A$
- Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

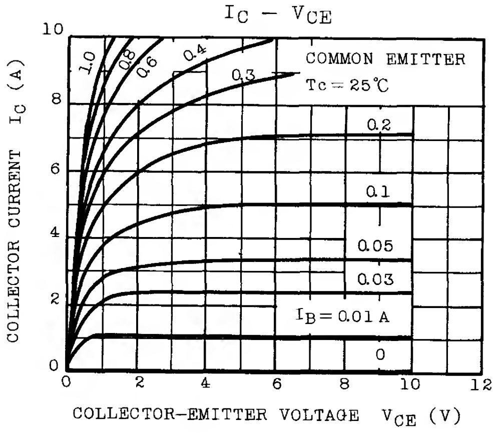
MAXIMUM RATINGS (Ta=25°C)

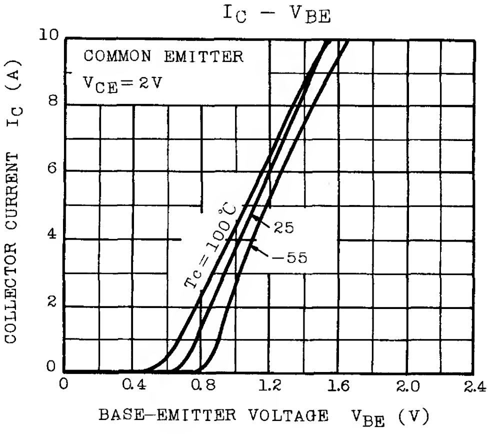
CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	100	V
* Collector-Emitter Voltage	V_{CEO}	80	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation (Tc=25°C)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	°C/W
* Junction Temperature	T_j	200	°C
* Storage Temperature Range	T_{stg}	-65 ~ 200	°C

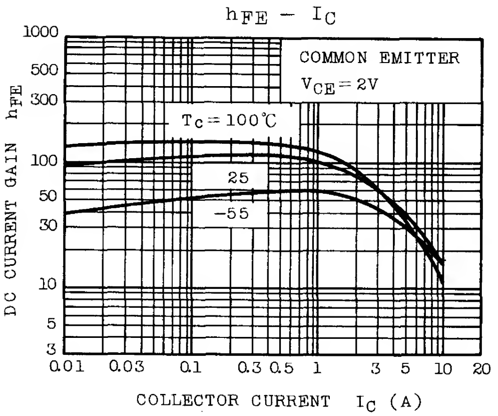
ELECTRICAL CHARACTERISTICS (Ta=25°C)

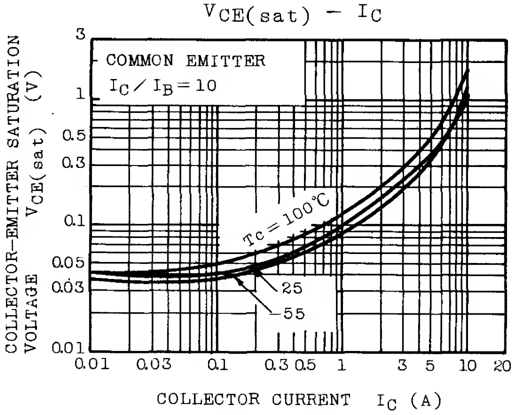
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	$V_{CE}=100V$, $V_{BE}=-1.5V$	-	-	1	mA
* Collector Cut-off Current		I_{CEX}	$V_{CE}=80V$, $V_{BE}=-1.5V$ Tc=150°C	-	-	10	mA
* Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	5	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=200mA$, $I_B=0$	80	-	-	V
* DC Current Gain		h_{FE}	$V_{CE}=2V$, $I_C=1A$	50	-	150	
			$V_{CE}=2V$, $I_C=3A$	30	-	-	
* Base-Emitter Voltage		V_{BE}	$V_{CE}=2V$, $I_C=3A$	-	-	1.5	V
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A$, $I_B=0.5A$	-	-	0.8	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A$, $I_B=0.5A$	-	-	1.5	V
Small Signal Forward Current Transfer Ratio		$\lvert h_{fe} \rvert$	$V_{CE}=10V$, $I_C=0.5A$ f=1MHz	4	-	-	

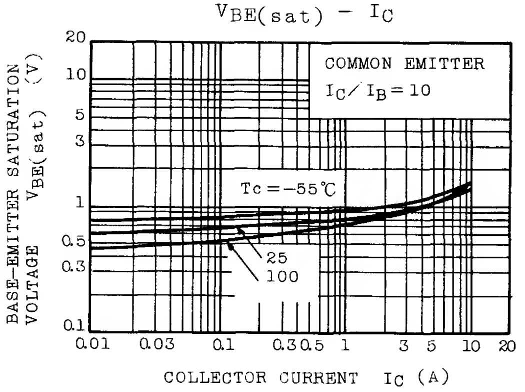
* In Accordance with JEDEC Registration Data.
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

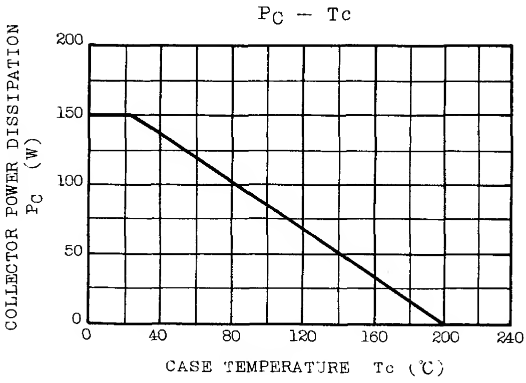

IC − VCE
COMMON EMITTER
Tc = 25℃
1.0
0.8
0.6
0.4
0.3
0.2
0.1
0.05
0.03
IB = 0.01 A
0
COLLECTOR CURRENT IC (A)
10
8
6
4
2
0
2
4
6
8
10
12
COLLECTOR-EMITTER VOLTAGE VCE (V)


IC − VBE
COMMON EMITTER
VCE = 2V
Tc = 100℃
25
−55
COLLECTOR CURRENT IC (A)
10
8
6
4
2
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE-EMITTER VOLTAGE VBE (V)


hFE − IC
COMMON EMITTER
VCE = 2V
Tc = 100℃
25
−55
DC CURRENT GAIN hFE
1000
500
300
100
50
30
10
5
3
0.01
0.03
0.1
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


VCE(sat) − IC
COMMON EMITTER
IC / IB = 10
Tc = 100℃
25
−55
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.01
0.03
0.1
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


VBE(sat) − IC
COMMON EMITTER
IC / IB = 10
Tc = −55℃
25
100
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
20
10
5
3
1
0.5
0.3
0.1
0.01
0.03
0.1
0.3
0.5
1
3
5
10
20
COLLECTOR CURRENT IC (A)


PC − Tc
COLLECTOR POWER DISSIPATION PC (W)
200
150
100
50
0
0
40
80
120
160
200
240
CASE TEMPERATURE Tc (℃)

SILICON NPN TRIPLE DIFFUSED TYPE

2N3771

HIGH POWER AMPLIFIER, POWER SWITCHING,
DC-DC CONVERTER AND REGULATOR APPLICATIONS

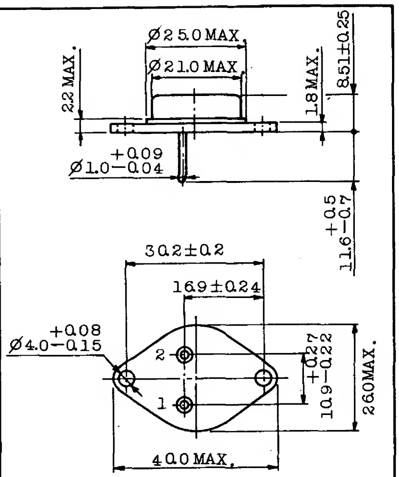
FEATURES:

. High Collector Dissipation : P_C=150W (Tc=25°C)
. High Collector Current : I_C=30A (D.C)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
※ Collector-Base Voltage		V_{CBO}	50	V
※ Collector-Emitter Voltage (V_{BE}=-1.5V, R_{BE}=100 Ω)		V_{CEX}	50	V
※ Collector-Emitter Voltage		V_{CEO}	40	V
※ Emitter-Base Voltage		V_{EBO}	5	V
※ Collector Current	DC	I_C	30	A
	Peak	I_{CM}	30	A
※ Base Current	DC	I_B	7.5	A
	Peak	I_{BM}	15	A
※ Collector Power Dissipation (Tc=25°C)		P_C	150	W
※ Junction Temperature		T_j	200	°C
※ Storage Temperature Range		T_{stg}	-65∿200	°C

Unit in mm



1. BASE
2. EMITTER
COLLECTOR(CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21D1A

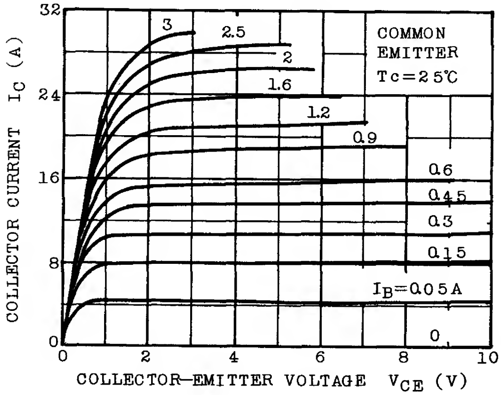
Weight : 12.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

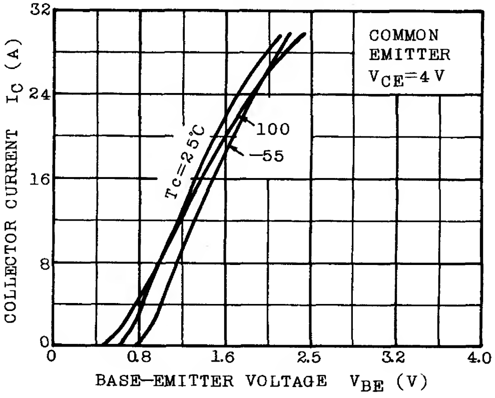
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※ Collector Cut-off Current	I_{CBO}	V_{CB}=50V, I_E=0	-	-	2	mA
※ Collector Cut-off Current	I_{CEX}	V_{CE}=50V, V_{BE}=-1.5V	-	-	2	mA
※ Collector Cut-off Current	I_{CEX}	V_{CE}=30V, V_{BE}=-1.5V Tc=150°C	-	-	10	mA
※ Collector Cut-off Current	I_{CEO}	V_{CE}=30V, I_B=0	-	-	10	mA
※ Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	5	mA
※ Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=200mA, I_B=0	40	-	-	V
※ DC Current Gain	h_{FE}	V_{CE}=4V, I_C=15A	15	-	60	
		V_{CE}=4V, I_C=30A	5	-	-	
※ Base-Emitter Voltage	V_{BE}	V_{CE}=4V, I_C=15A	-	-	2.7	V
※ Collector-Emitter	$V_{CE(sat)}$	I_C=15A, I_B=1.5A	-	-	2	V
		I_C=30A, I_B=6A	-	-	4	V
※ Transition Frequency	f_T	V_{CE}=4V, I_C=1A	0.2	-	-	MHz
※ Small Signal Forward Current Transfer Ratio	h_{fe}	V_{CE}=4V, I_C=1A f=1kHz	40	-	-	

※In Accordance with JEDEC Registration Data.

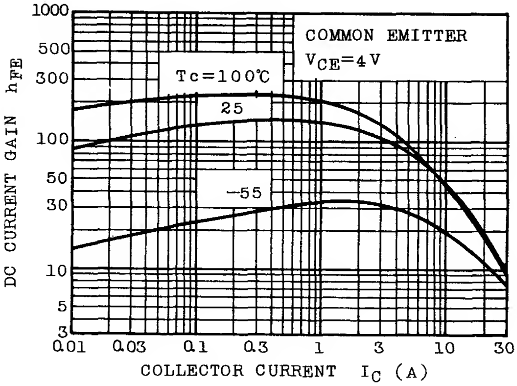
$I_C - V_{CE}$



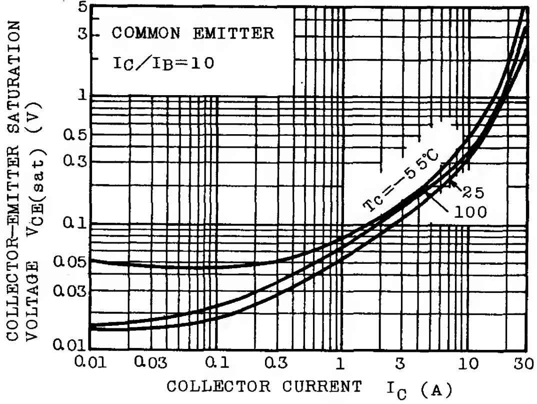
$I_C - V_{BE}$



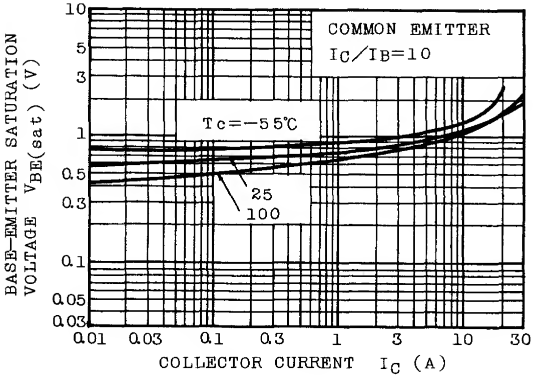
$h_{FE} - I_C$



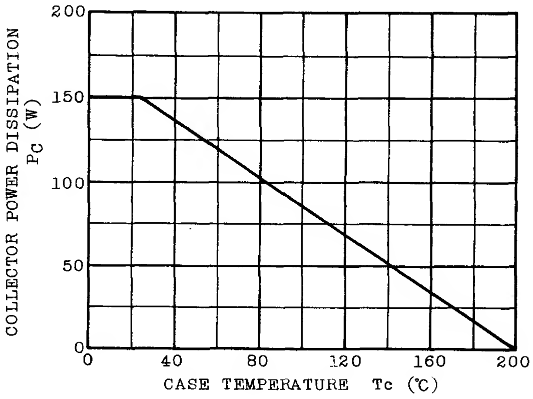
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - T_c$



SILICON NPN TRIPLE DIFFUSED TYPE

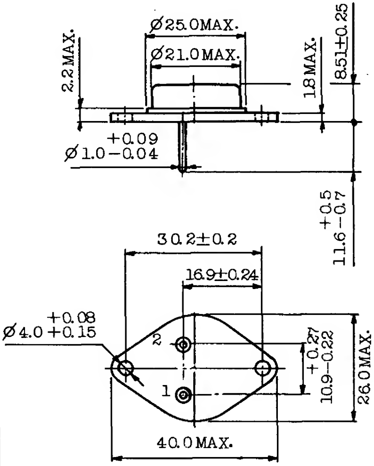
2N3772

HIGH POWER AMPLIFIER, POWER SWITCHING
DC-DC CONVERTER AND REGULATOR APPLICATIONS

FEATURES:

- High Collector Dissipation : P_C=150W (Tc=25°C)
- High Collector Current : I_C=20A (D.C)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

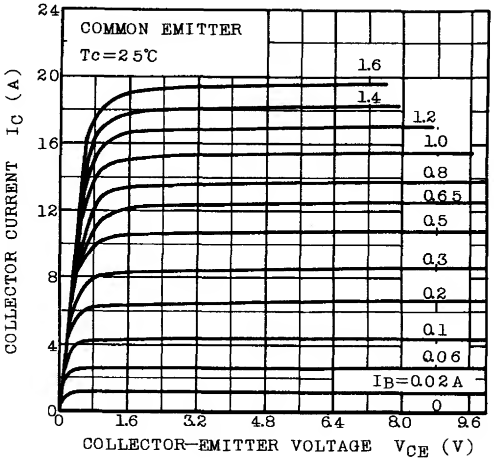
	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	100	V
※	Collector-Emitter Voltage (V_{BE}=-1.5V, R_{BE}=100Ω)		V_{CEX}	100	V
※	Collector-Emitter Voltage		V_{CEO}	60	V
※	Emitter-Base Voltage		V_{EBO}	7	V
※	Collector Current	DC	I_C	20	A
		Peak	I_{CM}	30	A
※	Base Current	DC	I_B	5	A
		Peak	I_{BM}	15	A
※	Collector Power Dissipation (Tc=25°C)		P_C	150	W
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65 ∿ 200	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

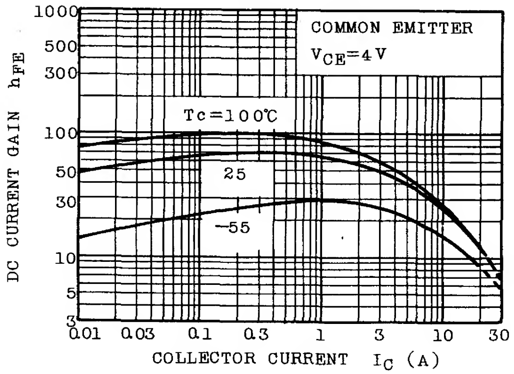
	CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current	I_{CBO}	V_{CB}=100V, I_E=0	-	-	5	mA
※	Collector Cut-off Current	I_{CEX}	V_{CE}=100V, V_{BE}=-1.5V	-	-	5	mA
※	Collector Cut-off Current	I_{CEX}	V_{CE}=30V, V_{BE}=-1.5V Tc=150°C	-	-	10	mA
※	Collector Cut-off Current	I_{CEO}	V_{CE}=50V, I_B=0	-	-	10	mA
※	Emitter Cut-off Current	I_{EBO}	V_{EB}=7V, I_C=0	-	-	5	mA
※	Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=200mA, I_B=0	60	-	-	V
※	DC Current Gain	h_{FE}	V_{CE}=4V, I_C=10A	15	-	60	
			V_{CE}=4V, I_C=20A	5	-	-	
※	Base-Emitter Voltage	V_{BE}	V_{CE}=4V, I_C=10A	-	1.0	2.2	V
※	Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10A, I_B=1A	-	0.3	1.4	V
			I_C=20A, I_B=4A	-	-	4	V
※	Transition Frequency	f_T	V_{CE}=4V, I_C=1A	0.2	-	-	MHz
※	Small Signal Current Gain	$\lvert h_{fe} \rvert$	V_{CE}=4V, I_C=1A, f=1kHz	40	-	-	

※ In Accordance with JEDEC Registration Data.

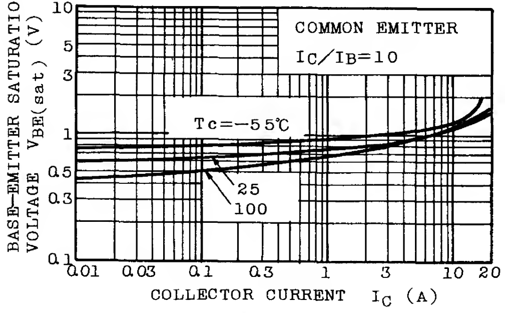
I_C – V_{CE}



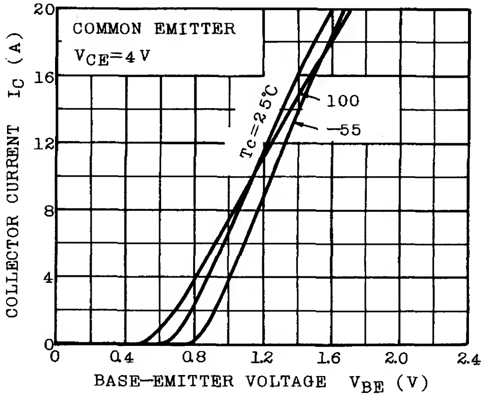
h_{FE} – I_C



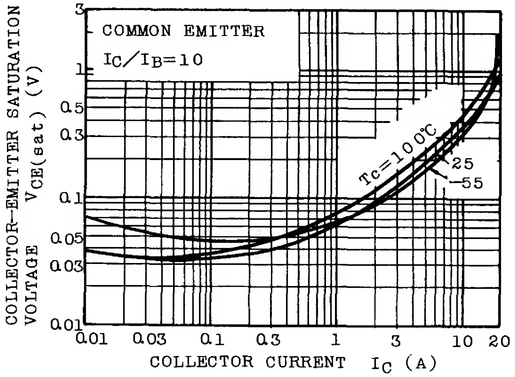
$V_{BE(sat)}$ – I_C



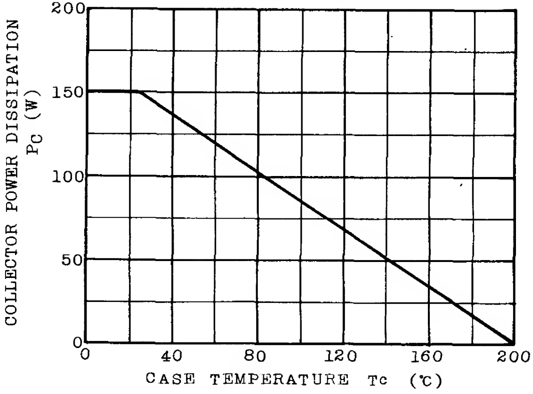
I_C – V_{BE}



$V_{CE(sat)}$ – I_C



P_C – T_C



SILICON NPN TRIPLE DIFFUSED TYPE

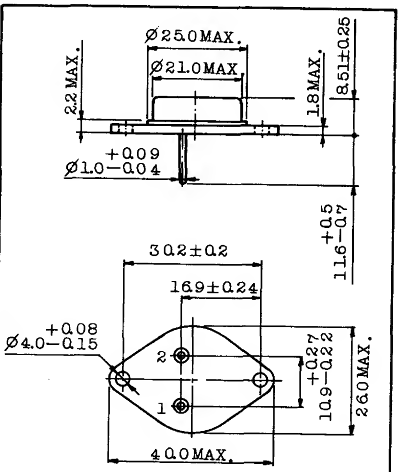
2N3773

HIGH POWER AMPLIFER, POWER SWITCHING,
DC-DC CONVERTER AND REGULATOR APPLICATIONS

FEATURES:

- High Collector-Emitter Sustaining Voltage:
  $V_{CEO(SUS)}=140V$ (Min.) @$I_C=0.2A$, $I_B=0$
- Excellent Area of Safe Operatings.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
※ Collector-Base Voltage		V_{CBO}	160	V
※ Collector-Emitter Voltage		V_{CEX}	160	V
※ Collector-Emitter Voltage		V_{CEO}	140	V
※ Emitter-Base Voltage		V_{EBO}	7	V
※ Collector Current	DC	I_C	16	A
	Peak	I_{CM}	30	A
※ Base Current	DC	I_B	4	A
	Peak	I_{BM}	15	A
※ Collector Power Dissipation (Tc=25°C)		P_C	150	W
Derate Linearly above 25°C			0.855	W/°C
※ Junction Temperature		T_j	200	°C
※ Storage Temperature		T_{stg}	-65～200	°C

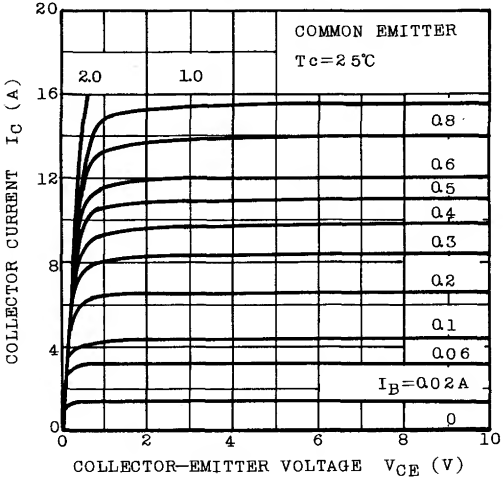
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※ Collector Cut-off Current	I_{CBO}	$V_{CB}=140V$, $I_E=0$	–	–	2.0	mA
※ Collector Cut-off Current	I_{CEX}	$V_{CE}=140V$, $V_{BE}=-1.5V$	–	–	2.0	mA
※ Collector Cut-off Current	I_{CEX}	$V_{CE}=140V$, $V_{BE}=-1.5V$, $Tc=150°C$	–	–	10	mA
※ Collector Cut-off Current	I_{CEO}	$V_{CE}=120V$, $I_B=0$	–	–	10	mA
※ Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V$, $I_C=0$	–	–	5.0	mA
※ Collector-Emitter Sustaining Voltage	$V_{CEX(SUS)}$ ※※	$I_C=0.1A$, $V_{BE}=-1.5V$ $R_{BE}=100\Omega$	160	–	–	V
※ Collector-Emitter Sustaining Voltage	$V_{CER(SUS)}$ ※※	$I_C=0.2A$, $R_{BE}=100\Omega$	150	–	–	V
※ Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$ ※※	$I_C=0.2A$, $I_B=0$	140	–	–	V
※ DC Current Gain	h_{FE}	$V_{CE}=4.0V$, $I_C=8A$	15	–	60	
		$V_{CE}=4.0V$, $I_C=16A$	5	–	–	
※ Base-Emitter Voltage	V_{BE}	$V_{CE}=4.0V$, $I_C=8A$	–	–	2.2	V
※ Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=8A$, $I_B=0.8A$	–	–	1.4	V
		$I_C=16A$, $I_B=3.2A$	–	–	4.0	V
※ Small Signal Current Gain	h_{fe}	$V_{CE}=4V$, $I_C=1.0A$, $f=1kHz$	40	–	–	
※ Small Signal Forward Current Transfer Ratio	$\lvert h_{fe}\rvert$	$V_{CE}=4V$, $I_C=1.0A$, $f=50kHz$	4	–	–	

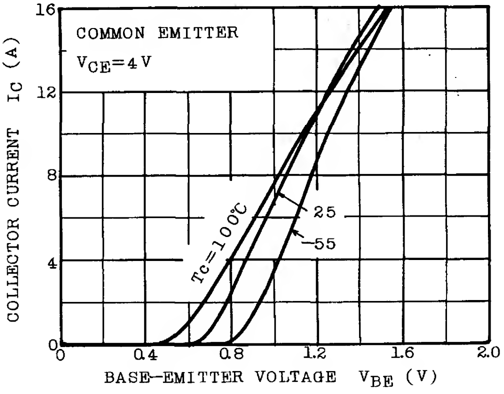
※In Accordance with JEDEC Registration Data.

※※The sustaining voltages $V_{CEX(SUS)}$, $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

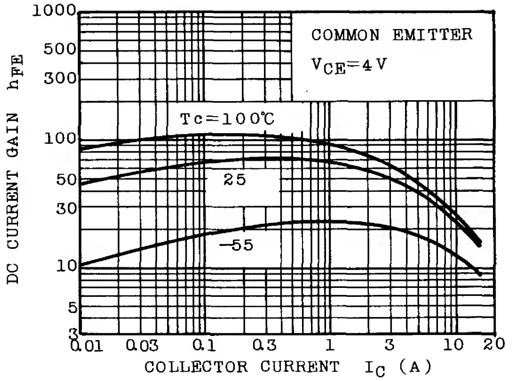
I_C — V_{CE}



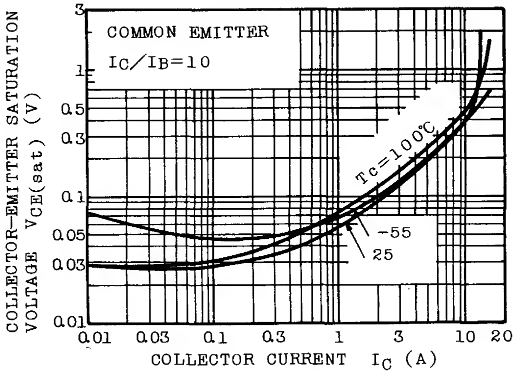
I_C — V_{BE}



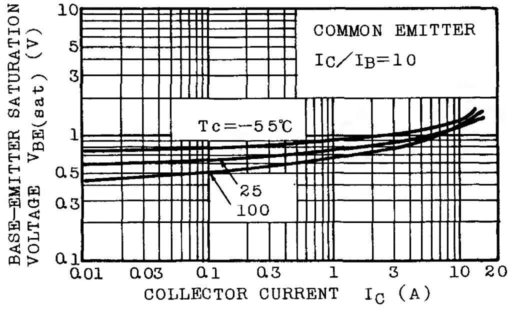
h_{FE} — I_C



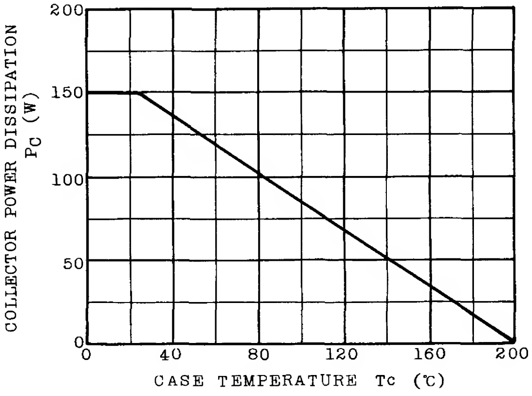
$V_{CE(sat)}$ — I_C



$V_{BE(sat)}$ — I_C



P_C — T_c



SILICON PNP TRIPLE DIFFUSED TYPE

2N3789

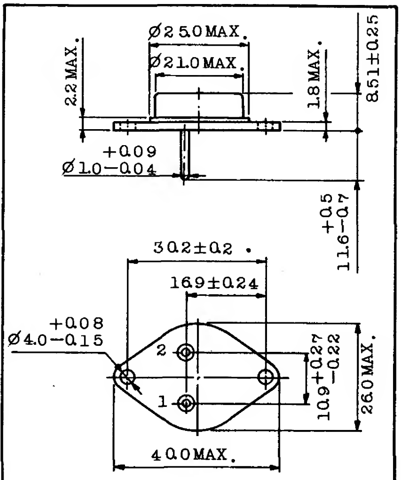
POWER AMPLIFIER, SWITCHING CIRCUIT AND REGULATOR APPLICATIONS.

FEATURES:

. High Gain and Excellent h_{FE} Linearity:
h_{FE}=15 (Min.) @ V_{CE}=-2V, I_C=-3A

. Low Saturation Voltage:
$V_{CE(sat)}$=-1.0V (Max.) @ I_C=-4A, I_B=-0.4A

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

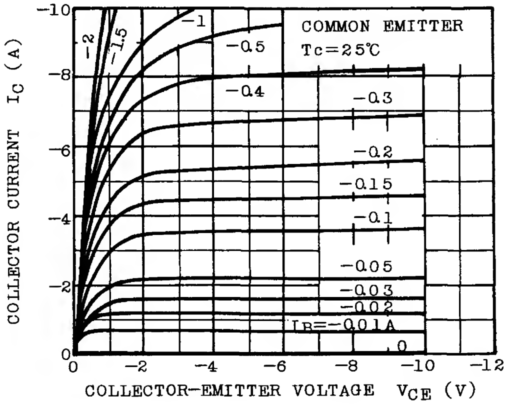
	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	-60	V
※	Collector-Emitter Voltage		V_{CEO}	-60	V
※	Emitter-Base Voltage		V_{EBO}	-7	V
※	Collector Current	DC	I_C	-10	A
		Peak	I_{CM}	-15	A
※	Base Current		I_B	-4	A
※	Collector Power Dissipation (Tc=25°C) Derate Linearly above 25°C		P_C	150	W
				0.86	W/°C
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65 ~ 200	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

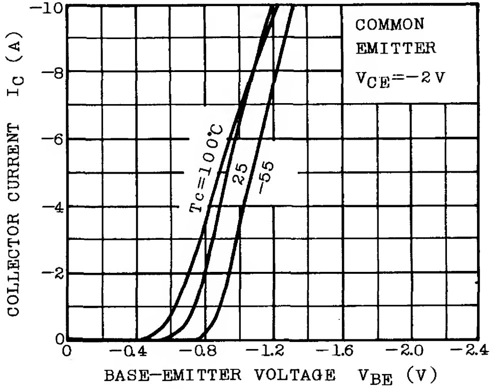
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current		I_{CEX}	V_{CE}=-60V, V_{BE}=1.5V	-	-	-1	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=-60V, V_{BE}=1.5V Tc=150°C	-	-	-5	mA
※	Collector Cut-off Current		I_{CEO}	V_{CE}=-30V, I_B=0	-	-	-10	mA
※	Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-5	mA
※	Collector-Emitter Sustaining Voltage		※※ $V_{CEO(SUS)}$	I_C=-0.2A, I_B=0	-60	-	-	V
※	DC Current Gain		h_{FE}	V_{CE}=-2V, I_C=-1A	25	-	90	
				V_{CE}=-2V, I_C=-3A	15	-	-	
※	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-1.0	V
		Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-2.0	V
※	Transition Frequency		f_T	V_{CE}=-10V, I_C=-0.5A, f=1MHz	4	-	-	MHz
	Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	500	pF

※In accordance with JEDEC registration data.

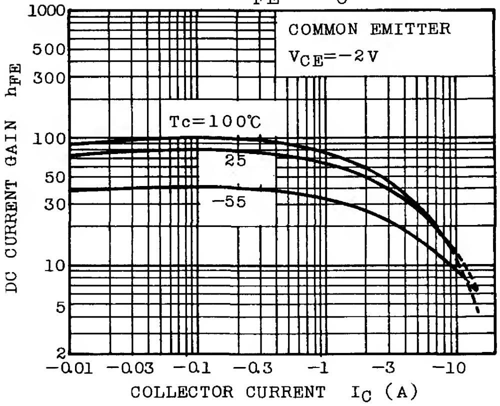
※※The sustaining voltage VCEO(SUS) MUST NOT be measured on a curve tracer.



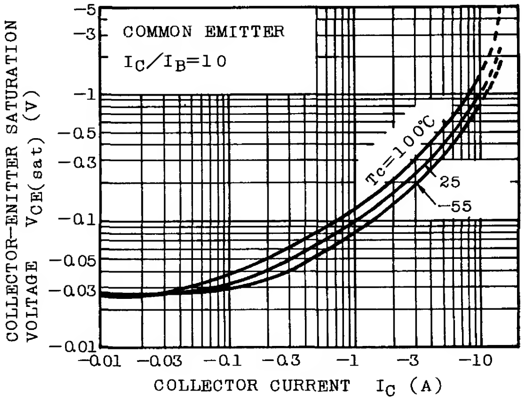
$I_C - V_{CE}$



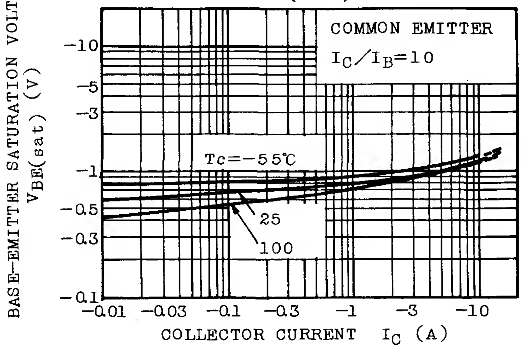
$I_C - V_{BE}$



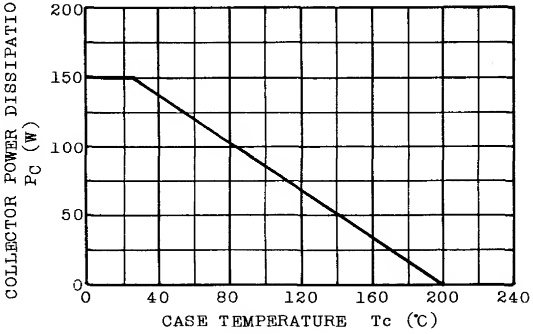
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Tc$

SILICON PNP TRIPLE DIFFUSED TYPE

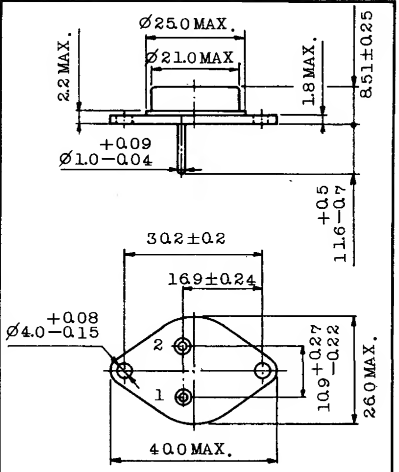
2N3790

POWER AMPLIFIER, SWITCHING CIRCUIT AND REGULATOR APPLICATIONS.

FEATURES:

- High Gain and Excellent h_{FE} Linearity:
  h_{FE}=15(Min.) @ V_{CE}=-2V, I_C=-3A
- Low Saturation Voltage:
  $V_{CE(sat)}$=-1.0V(Max.) @ I_C=-4A, I_B=-0.4A

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

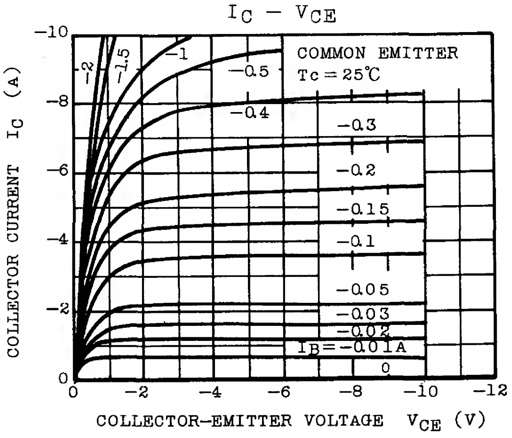
MAXIMUM RATINGS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	-80	V
※	Collector-Emitter Voltage		V_{CEO}	-80	V
※	Emitter-Base Voltage		V_{EBO}	-7	V
※	Collector Current	DC	I_C	-10	A
		Peak	I_{CM}	-15	A
※	Base Current		I_B	-4	A
※	Collector Power Dissipation (Tc=25°C)		P_C	150	W
	Derate Linearly above 25°C			0.86	W/°C
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65~ 200	°C

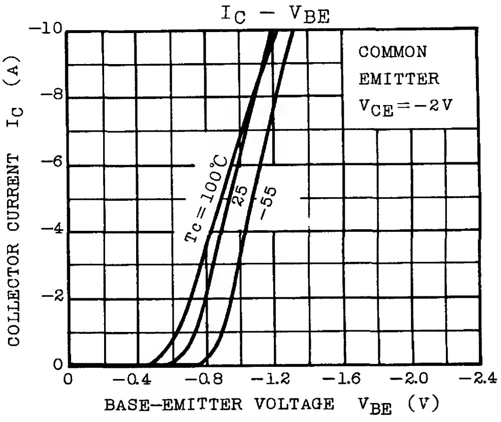
ELECTRICAL CHARACTERISTICS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current		I_{CEX}	V_{CE}=-80V, V_{BE}=1.5V	-	-	-1	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=-80V, V_{BE}=1.5V Tc=150°C	-	-	-5	mA
※	Collector Cut-off Current		I_{CEO}	V_{CE}=-40V, I_B=0	-	-	-10	mA
※	Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-5	mA
※	Collector-Emitter Sustaining Voltage		※※ $V_{CEO(SUS)}$	I_C=-0.2A, I_B=0	-80	-	-	V
※	DC Current Gain		h_{FE}	V_{CE}=-2V, I_C=-1A	25	-	90	
				V_{CE}=-2V, I_C=-3A	15	-	-	
※	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-1.0	V
		Base-Emitter	$V_{BE(sat)}$	I_C=-4A, I_B=-0.4A	-	-	-2.0	V
※	Transition Frequency		f_T	V_{CE}=-10V, I_C=-0.5A, f=1MHz	4	-	-	MHz
※	Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	500	pF

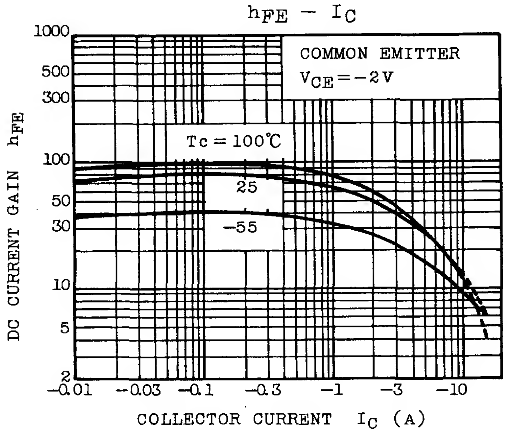
※In accordance with JEDEC registration data.
※※The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



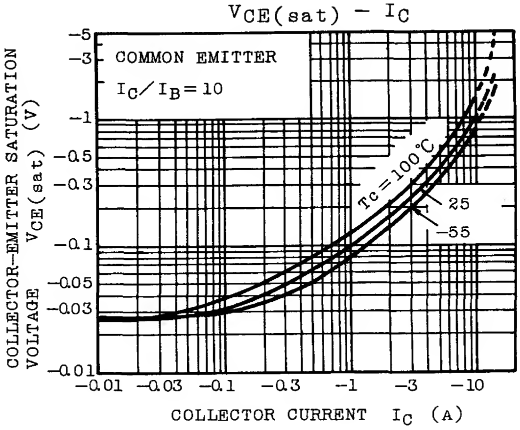
$I_C - V_{CE}$
COMMON EMITTER
Tc = 25℃
−2
−1.5
−1
−0.5
−0.4
−0.3
−0.2
−0.15
−0.1
−0.05
−0.03
−0.02
$I_B = -0.01$ A
0
COLLECTOR CURRENT I_C (A)
−10
−8
−6
−4
−2
0
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)
0
−2
−4
−6
−8
−10
−12



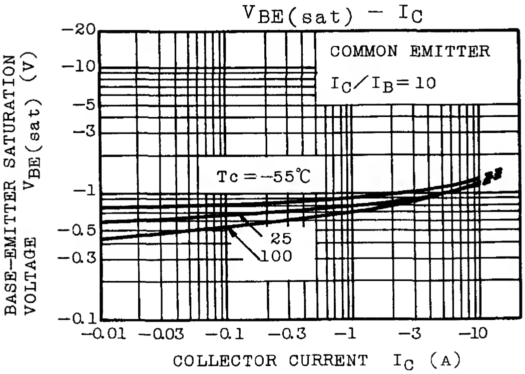
$I_C - V_{BE}$
COMMON EMITTER
$V_{CE} = -2$ V
Tc = 100℃
25
−55
COLLECTOR CURRENT I_C (A)
−10
−8
−6
−4
−2
0
BASE–EMITTER VOLTAGE V_{BE} (V)
0
−0.4
−0.8
−1.2
−1.6
−2.0
−2.4



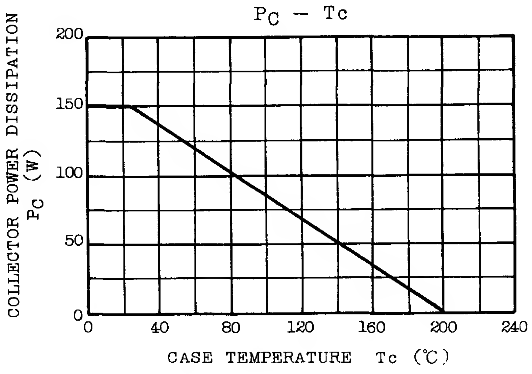
$h_{FE} - I_C$
COMMON EMITTER
$V_{CE} = -2$ V
Tc = 100℃
25
−55
DC CURRENT GAIN h_{FE}
1000
500
300
100
50
30
10
5
2
COLLECTOR CURRENT I_C (A)
−0.01
−0.03
−0.1
−0.3
−1
−3
−10



$V_{CE(sat)} - I_C$
COMMON EMITTER
$I_C / I_B = 10$
Tc = 100℃
25
−55
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.03
−0.01
COLLECTOR CURRENT I_C (A)
−0.01
−0.03
−0.1
−0.3
−1
−3
−10



$V_{BE(sat)} - I_C$
COMMON EMITTER
$I_C / I_B = 10$
Tc = −55℃
25
100
BASE–EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
−20
−10
−5
−3
−1
−0.5
−0.3
−0.1
COLLECTOR CURRENT I_C (A)
−0.01
−0.03
−0.1
−0.3
−1
−3
−10



$P_C - T_c$
COLLECTOR POWER DISSIPATION P_C (W)
200
150
100
50
0
CASE TEMPERATURE Tc (℃)
0
40
80
120
160
200
240

SILICON PNP TRIPLE DIFFUSED TYPE

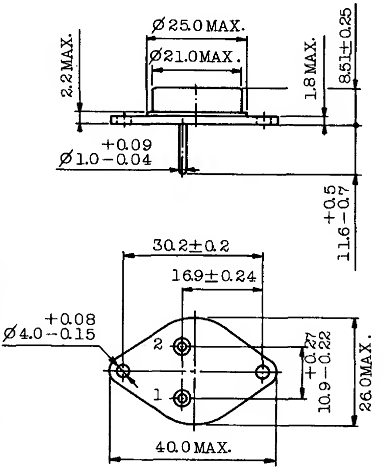
2N3791

POWER AMPLIFIER, SWITCHING CIRCUIT AND REGULATOR APPLICATIONS

FEATURES:

- High Gain and Excellent h_{FE} Linearity:
  h_{FE}=30 (Min.) @ V_{CE}=-2V, I_C=-3A
- Low Saturation Voltage:
  $V_{CE(sat)}$=-1.0V (Max.) @ I_C=-5A, I_B=-0.5A

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO-204MA/TO-3
EIAJ	TC-3. TB-3
TOSHIBA	2-21D1A

Weight : 12.6g

MAXIMUM RATINGS (T_a=25°C)

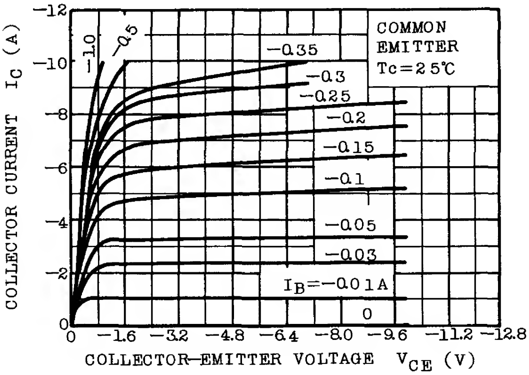
CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	-60	V
* Collector-Emitter Voltage		V_{CEO}	-60	V
* Emitter-Base Voltage		V_{EBO}	-7	V
* Collector Current	DC	I_C	-10	A
	Peak	I_{CM}	-15	A
* Base Current		I_B	-4	A
* Collector Power Dissipation (T_c=25°C)		P_C	150	W
Derate Linearly above 25°C			0.86	W/°C
* Junction Temperature		T_j	200	°C
* Storage Temperature Range		T_{stg}	-65 ∿ 200	°C

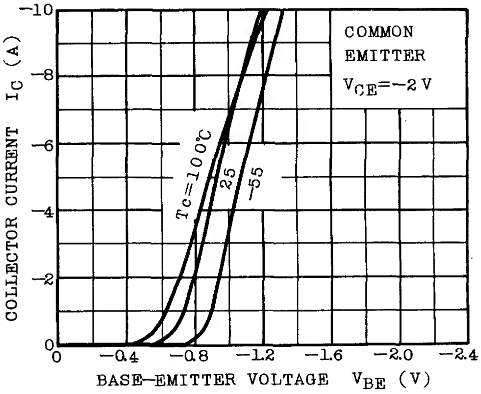
ELECTRICAL CHARACTERISTICS (T_a=25°C)

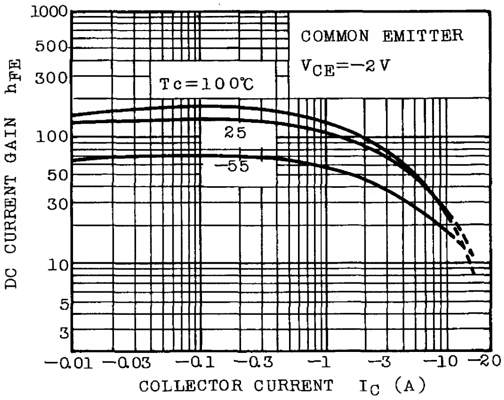
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	V_{CE}=-60V, V_{BE}=1.5V	-	-	-1	mA
* Collector Cut-off Current		I_{CEX}	V_{CE}=-60V, V_{BE}=1.5V, T_c=150°C	-	-	-5	mA
* Collector Cut-off Current		I_{CEO}	V_{CE}=-30V, I_B=0	-	-	-10	mA
* Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-5	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=-0.2A, I_B=0	-60	-	-	V
* DC Current Gain		h_{FE}	V_{CE}=-2V, I_C=-1A	50	-	150	
			V_{CE}=-2V, I_C=-3A	30	-	-	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-1.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-1.5	V
* Transition Frequency		f_T	V_{CE}=-10V, I_C=-0.5A f=1MHz	4	-	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	500	pF

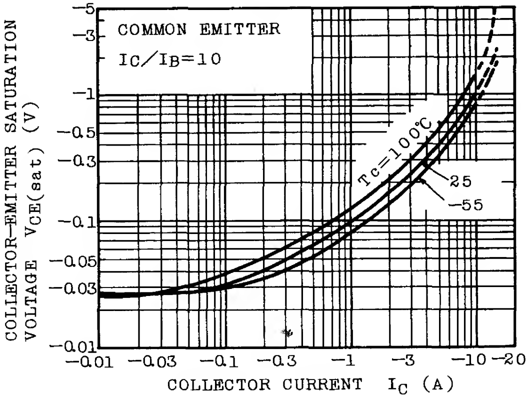
* In Accordance with JEDEC Registration Data.

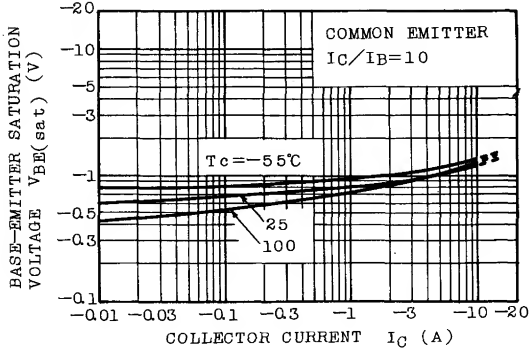
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

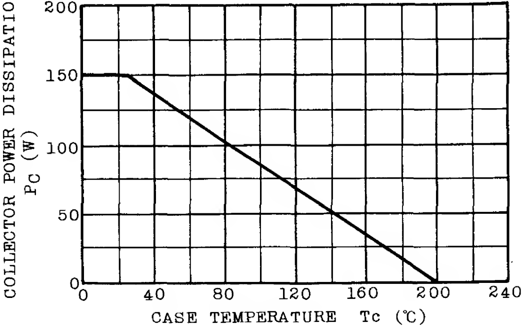

I_C – V_{CE}


I_C – V_{BE}


h_{FE} – I_C


$V_{CE(sat)}$ – I_C


$V_{BE(sat)}$ – I_C


P_C – Tc

SILICON PNP TRIPLE DIFFUSED TYPE

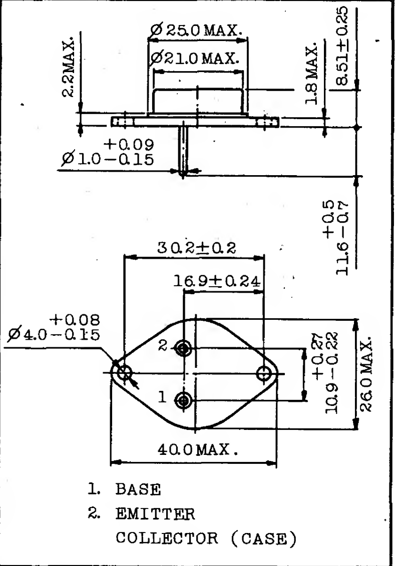
2N3792

POWER AMPLIFIER, SWITCHING CIRCUIT AND REGULATOR APPLICATIONS.

FEATURES:

- High Gain and Excellent h_{FE} Linearity:
  h_{FE}=30 (Min.) @ V_{CE}=-2V, I_C=-3A
- Low Saturation Voltage:
  $V_{CE(sat)}$=-1.0V (Max.) @ I_C=-5A, I_B=-0.5A

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3．TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	-80	V
* Collector-Emitter Voltage		V_{CEO}	-80	V
* Emitter-Base Voltage		V_{EBO}	-7	V
* Collector Current	DC	I_C	-10	A
	Peak	I_{CM}	-15	A
* Base Current		I_B	-4	A
* Collector Power Dissipation (Tc=25°C)		P_C	150	W
Derate Linearly above 25°C			0.86	W/°C
* Junction Temperature		T_j	200	°C
* Storage Temperature Range		T_{stg}	-65～200	°C

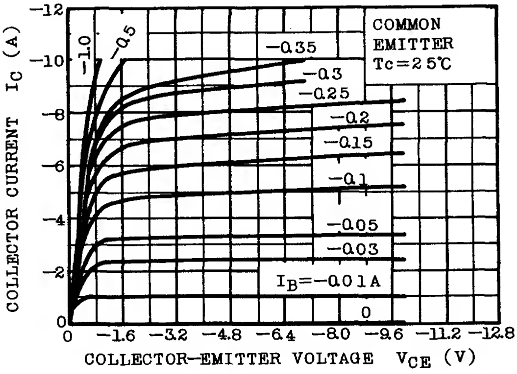
ELECTRICAL CHARACTERISTICS (ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	V_{CE}=-80V, V_{BE}=1.5V	-	-	-1	mA
* Collector Cut-off Current		I_{CEX}	V_{CE}=-80V, V_{BE}=1.5V Tc=150°C	-	-	-5	mA
* Collector Cut-off Current		I_{CEO}	V_{CE}=-40V, I_B=0	-	-	-10	mA
* Emitter Cut-off Current		I_{EBO}	V_{EB}=-7V, I_C=0	-	-	-5	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=-0.2A, I_B=0	-80	-	-	V
* DC Current Gain		h_{FE}	V_{CE}=-2V, I_C=-1A	50	-	150	
			V_{CE}=-2V, I_C=-3A	30	-	-	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-1.0	V
	Base-Emitter	$V_{BE(sat)}$	I_C=-5A, I_B=-0.5A	-	-	-1.5	V
* Transition Frequency		f_T	V_{CE}=-10V, I_C=-0.5A f=1MHz	4	-	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	-	500	pF

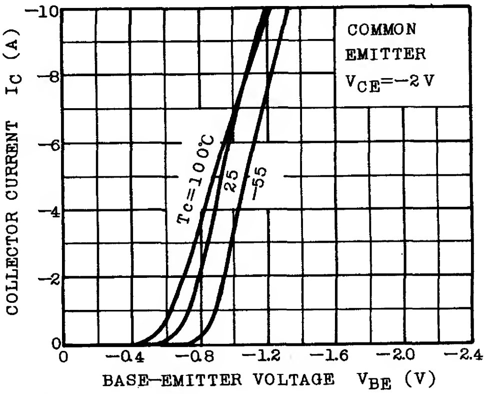
* In Accordance with JEDEC Registration Data.

** The sustaining voltage $V_{CE(SUS)}$ MUST NOT be measured on a curve tracer.

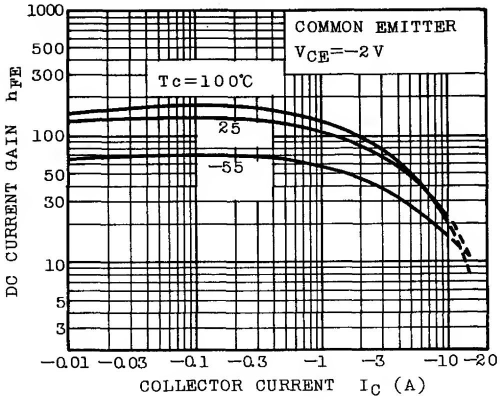
I_C − V_{CE}



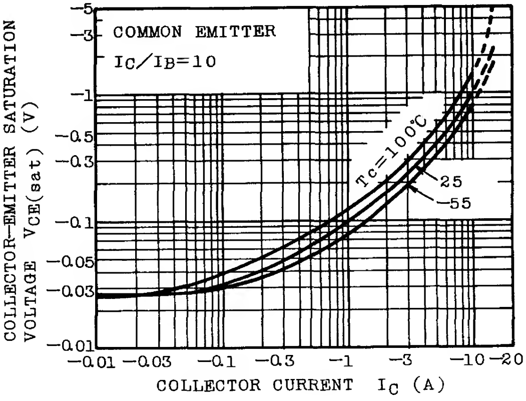
I_C − V_{BE}



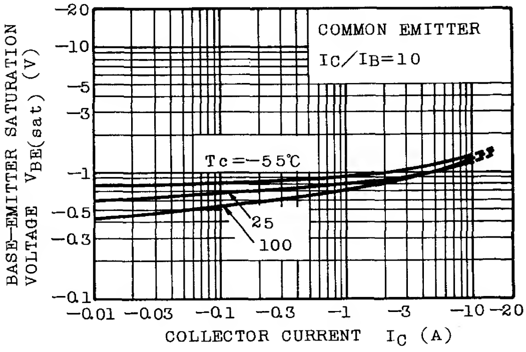
h_{FE} − I_C



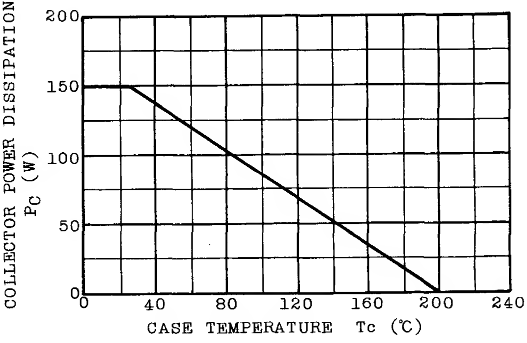
$V_{CE(sat)}$ − I_C



$V_{BE(sat)}$ − I_C



P_C − Tc



SILICON PNP TRIPLE DIFFUSED TYPE

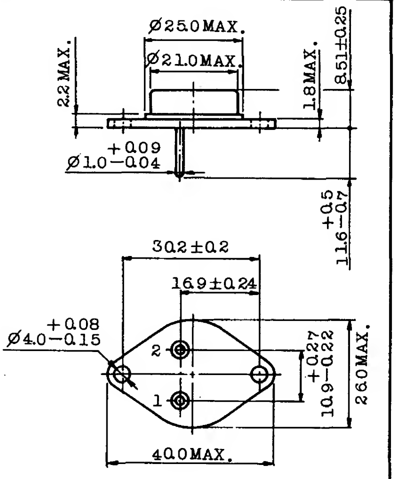
2N4398

HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
  - h_{FE}=5.0 (Min.) @ V_{CE}=-4.0V, I_C=-30A
  - $V_{CE(sat)}$=-4.0V (Max.) @ I_C=-30A, I_B=-6A
- Low Saturation Voltage:
  - $V_{CE(sat)}$=-0.75V (Max.) @ I_C=-10A, I_B=-1.0A
  - $V_{BE(sat)}$=-1.6V (Max.) @ I_C=-10A, I_B=-1.0A
- High Collector Power Dissipation Capability:
  - P_C=200W (Max.)
- Complementary to 2N5301

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
※ Collector-Base Voltage		V_{CBO}	-40	V
※ Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	-40	V
※ Emitter-Base Voltage		V_{EBO}	-5.0	V
※ Collector Current	DC	I_C	-30	A
	Peak		-50	A
※ Base Current	DC	I_B	-7.5	A
	Peak		-15	A
※ Collector Power Dissipation	Ta=25°C	P_C	5.0	W
	Derate above 25°C		28.6	mW/°C
	Tc=25°C	P_C	200	W
	Derate above 25°C		1.15	W/°C
※ Junction Temperature		T_j	200	°C
※ Storage Temperature Range		T_{stg}	-65 ~ 200	°C

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP	MAX.	UNIT
※	Collector Cut-off Current		I_{CBO}	$V_{CB}=-40V$, $I_E=0$	-	-	-1.0	mA
※	Collector Cut-off Current		I_{CEX}	$V_{CE}=-40V$, $V_{BE}=1.5V$	-	-	-5.0	mA
※	Collector Cut-off Current		I_{CEX}	$V_{CE}=-30V$, $V_{BE}=1.5V$, $T_c=150^\circ C$	-	-	10	mA
※	Collector Cut-off Current		I_{CEO}	$V_{CE}=-40V$, $I_B=0$	-	-	-5.0	mA
※	Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-5.0	mA
※	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ ※※	$I_C=-200mA$, $I_B=0$	-40	-	-	V
※	DC Current Gain		h_{FE}	$V_{CE}=-2.0V$, $I_C=-1.0A$	40	-	-	
				$V_{CE}=-2.0V$, $I_C=-15A$	15	-	60	
				$V_{CE}=-4.0V$, $I_C=-30A$	5.0	-	-	
※	Base-Emitter Voltage		V_{BE}	$V_{CE}=-2.0V$, $I_C=-15A$	-	-	-1.7	V
				$V_{CE}=-4.0V$, $I_C=-30A$	-	-	-3.0	V
※	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-10A$, $I_B=-1.0A$	-	-	-0.75	V
				$I_C=-15A$, $I_B=-1.5A$	-	-	-1.0	V
				$I_C=-20A$, $I_B=-2.0A$	-	-	-2.0	V
				$I_C=-30A$, $I_B=-6.0A$	-	-	-4.0	V
※	Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-10A$, $I_B=-1.0A$	-	-	-1.6	V
				$I_C=-15A$, $I_B=-1.5A$	-	-	-1.85	V
				$I_C=-20A$, $I_B=-2.0A$	-	-	-2.5	V
※	Transition Frequency		f_T	$V_{CE}=-10V$, $I_C=-1.0A$, f=1.0MHz	2.0	-	-	MHz
※	Small-Signal Current Gain		h_{fe}	$V_{CE}=-10V$, $I_C=-1.0A$, f=1.0kHz	40	-	-	
※	Switching Time	Rise Time	t_r	See Fig.1-1	-	-	0.4	μs
		Storage Time	t_{stg}	See Fig.1-2	-	-	1.5	μs
		Fall Time	t_f		-	-	0.6	μs

※ In Accordance with JEDEC Registration Data.
※※ The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

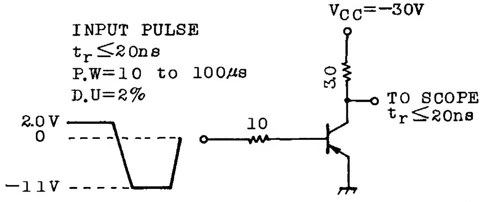
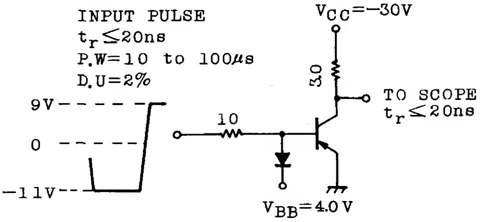
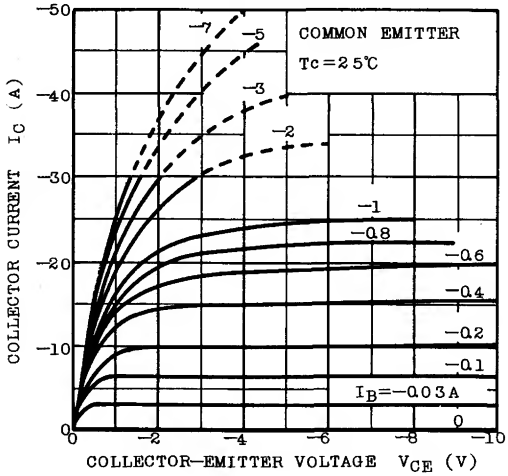


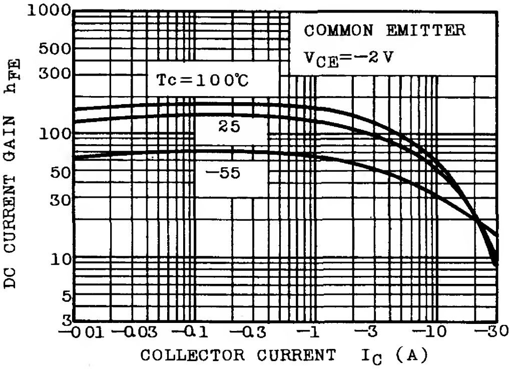
Fig.1-2 TURN-OFF TIME



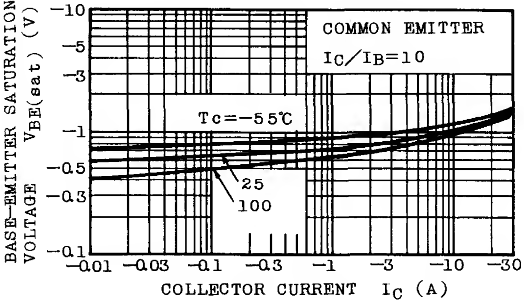
$I_C - V_{CE}$



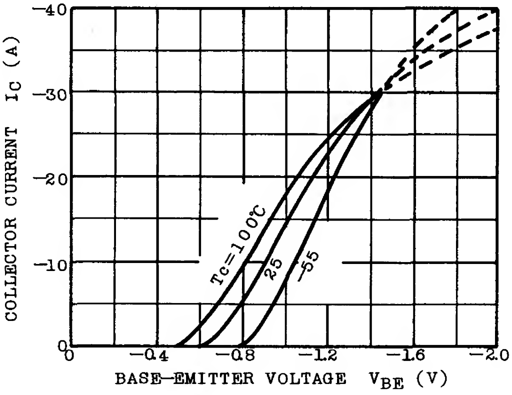
$h_{FE} - I_C$



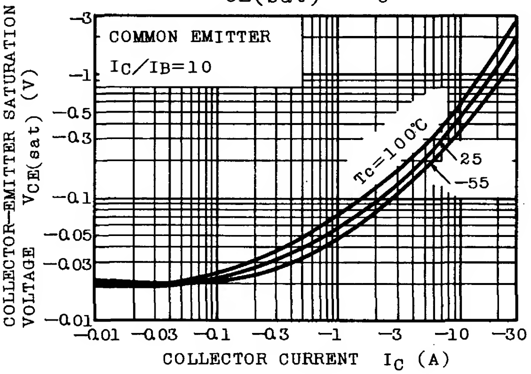
$V_{BE(sat)} - I_C$



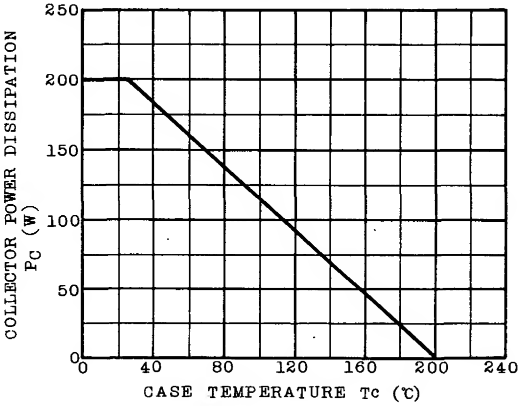
$I_C - V_{BE}$



$V_{CE(sat)} - I_C$



$P_C - T_c$



2N4399

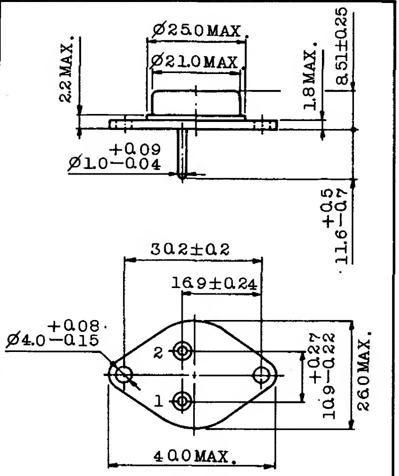
SILICON PNP TRIPLE DIFFUSED TYPE

HIGH POWER SWITCHING,AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A :
  - h_{FE}=5.0 (Min.) @ V_{CE}=-4.0V, I_C=-30A
  - $V_{CE(sat)}$=-4.0V (Max.) @ I_C=-30A, I_B=-6A
- Low Saturation Voltage :
  - $V_{CE(sat)}$=-0.75V (Max.) @ I_C=-10A, I_B=-1.0A
  - $V_{BE(sat)}$=-1.6V (Max.) @ I_C=-10A, I_B=-1.0A
- High Collector Power Dissipation Capability :
  - P_C=200W (Max.)
- Complementary to 2N5302

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
※ Collector-Base Voltage		V_{CBO}	-60	V
※ Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	-60	V
※ Emitter-Base Voltage		V_{EBO}	-5.0	V
※ Collector Current	DC	I_C	-30	A
	Peak		-50	A
※ Base Current	DC	I_B	-7.5	A
	Peak		-15	A
※ Collector Power Dissipation	Ta=25°C	P_C	5.0	W
	Derate above 25°C		28.6	mW/°C
	Tc=25°C	P_C	200	W
	Derate above 25°C		1.15	W/°C
※ Junction Temperature		T_j	200	°C
※ Storage Temperature Range		T_{stg}	-65 ~ 200	°C

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current		I_{CBO}	$V_{CB}=-60V,\ I_E=0$	-	-	-1.0	mA
※	Collector Cut-off Current		I_{CEX}	$V_{CE}=-60V,\ V_{BE}=1.5V$	-	-	-5.0	mA
※	Collector Cut-off Current		I_{CEX}	$V_{CE}=-30V,\ V_{BE}=1.5V,\ T_c=150^{\circ}C$	-	-	-10	mA
※	Collector Cut-off Current		I_{CEO}	$V_{CE}=-60V,\ I_B=0$	-	-	-5.0	mA
※	Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-5.0	mA
※	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ ※※	$I_C=-200mA,\ I_B=0$	-60	-	-	V
※	DC Current Gain		h_{FE}	$V_{CE}=-2.0V,\ I_C=-1.0A$	40	-	-	
				$V_{CE}=-2.0V,\ I_C=-15A$	15	-	60	
				$V_{CE}=-4.0V,\ I_C=-30A$	5.0	-	-	
※	Base-Emitter Voltage		V_{BE}	$V_{CE}=-2.0V,\ I_C=-15A$	-	-	-1.7	V
				$V_{CE}=-4.0V,\ I_C=-30A$	-	-	-3.0	V
※	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-10A,\ I_B=-1.0A$	-	-	-0.75	V
				$I_C=-15A,\ I_B=-1.5A$	-	-	-1.0	V
				$I_C=-20A,\ I_B=-2.0A$	-	-	-2.0	V
				$I_C=-30A,\ I_B=-6.0A$	-	-	-4.0	V
※	Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-10A,\ I_B=-1.0A$	-	-	-1.6	V
				$I_C=-15A,\ I_B=-1.5A$	-	-	-1.85	V
				$I_C=-20A,\ I_B=-2.0A$	-	-	-2.5	V
※	Transition Frequency		f_T	$V_{CE}=-10V,\ I_C=-1.0A,\ f=1.0MHz$	2.0	-	-	MHz
※	Small-Signal Current Gain		h_{fe}	$V_{CE}=-10V,\ I_C=-1.0A,\ f=1.0kHz$	40	-	-	
※	Switching Time	Rise Time	t_r	See Fig. 1-1	-	-	0.4	µs
		Storage Time	t_{stg}	See Fig.1-2	-	-	1.5	µs
		Fall Time	t_f		-	-	0.6	µs

※InAccodance with JEDEC Registration Data.

※※The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

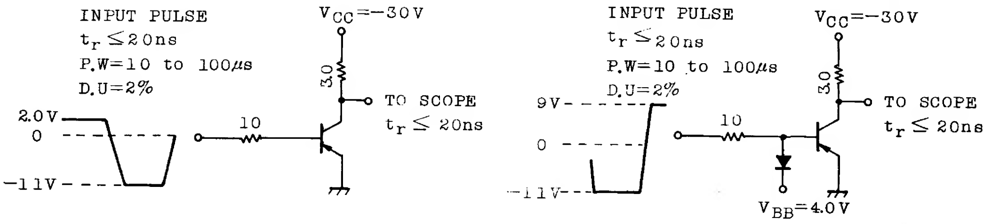
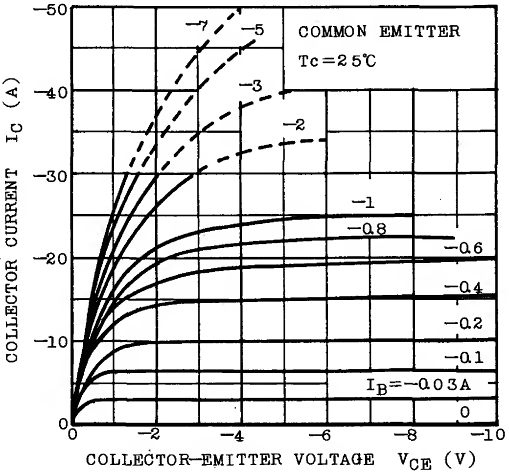


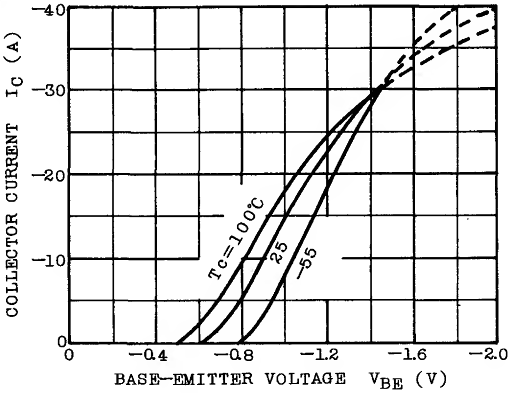
Fig. 1-1 TURN-ON TIME

Fig. 1-2 TURN-OFF TIME

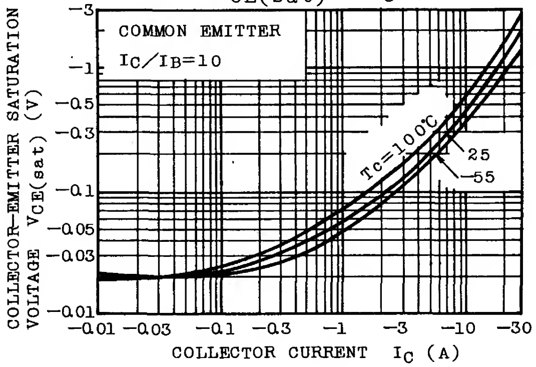
I_C — V_{CE}



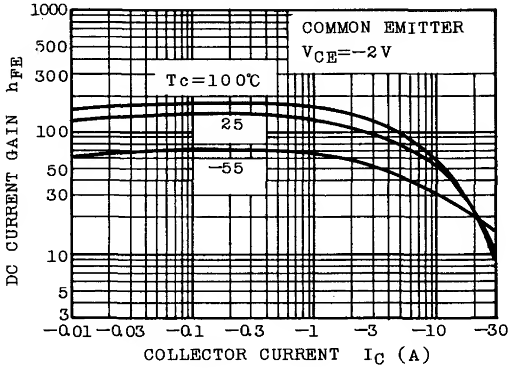
I_C — V_{BE}



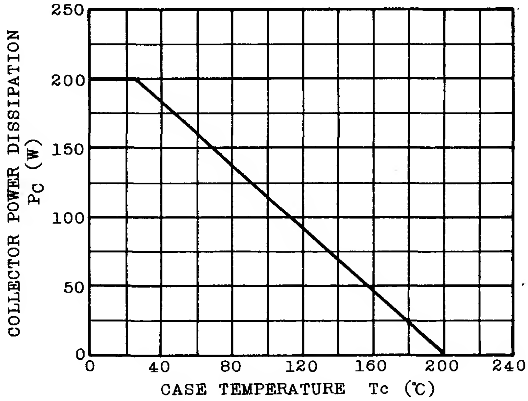
$V_{CE(sat)}$ — I_C



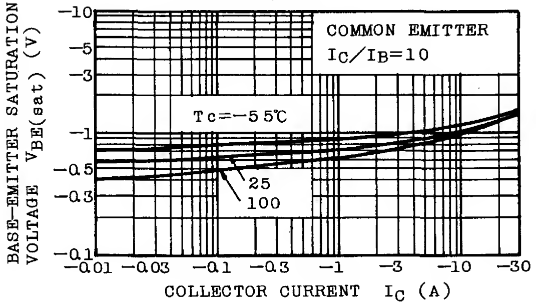
h_{FE} — I_C



P_C — Tc



$V_{BE(sat)}$ — I_C



SILICON NPN TRIPLE DIFFUSED TYPE

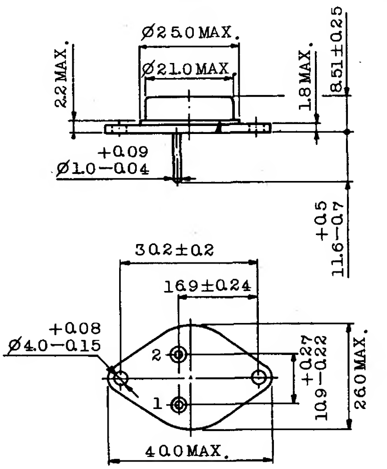
2N5038

DC-DC CONVERTER, SWITCHING REGULATOR AND HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Excellent Switching Times
  : $t_r < 0.5\mu s$, $t_f < 0.5\mu s$ @ $I_C=12A$, $I_B=1.2A$
- Low Saturation Voltage
  : $V_{CE(sat)} < 2.5V$ @ $I_C=20A$, $I_B=5A$

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR(CASE)

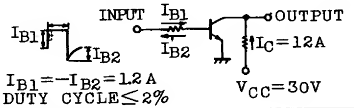
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

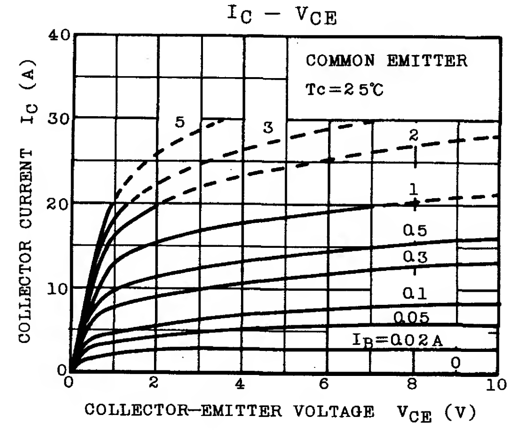
MAXIMUM RATINGS ($T_a=25^\circ C$)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
*	Collector-Base Voltage		V_{CBO}	150	V
	Collector-Emitter Sustaining Voltage ($V_{BE}=-1.5V$, $R_{BE}=100\Omega$)		$V_{CEX(SUS)}$	150	V
*	Emitter-Base Voltage		V_{EBO}	7	V
*	Collector Current	DC	I_C	20	A
		Peak	I_{CM}	30	A
*	Base Current		I_B	5	A
*	Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly above 25°C		P_C	140	W
				0.8	W/°C
*	Junction Temperature		T_j	200	°C
*	Storage Temperature Range		T_{stg}	-65~ 200	°C

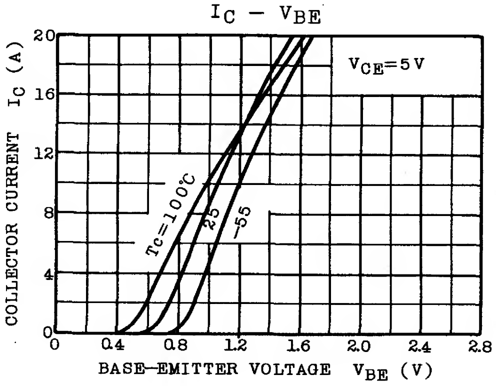
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEX}	$V_{CE}=140V$, $V_{BE}=-1.5V$	-	-	50	mA
*	Collector Cut-off Current		I_{CEX}	$V_{CE}=100V$, $V_{BE}=-1.5V$, $T_c=150^\circ C$	-	-	10	mA
*	Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	5	mA
				$V_{EB}=7V$, $I_C=0$	-	-	50	mA
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=0.2A$, $I_B=0$	90	-	-	V
*	DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=2A$	50	-	250	
				$V_{CE}=5V$, $I_C=12A$	20	-	100	
*	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=20A$, $I_B=5A$	-	-	2.5	V
		Base-Emitter	$V_{BE(sat)}$	$I_C=20A$, $I_B=5A$	-	-	3.3	V
*	Small Signal Forward Current Transfer Ratio		$\|h_{fe}\|$	$V_{CE}=10V$, $I_C=2A$, $f=5MHz$	12	-	-	
*	Switching Time	Rise Time	t_r	 INPUT I_{B1} I_{B2} OUTPUT $I_C=12A$ $V_{CC}=30V$ $I_{B1}=-I_{B2}=1.2A$ DUTY CYCLE≤2%	-	-	0.5	μs
		Storage Time	t_{stg}		-	-	1.5	μs
		Fall Time	t_f		-	-	0.5	μs

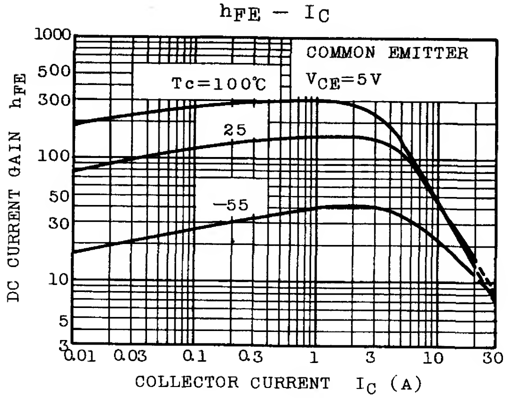
* In accordance with JEDEC registration data.
** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



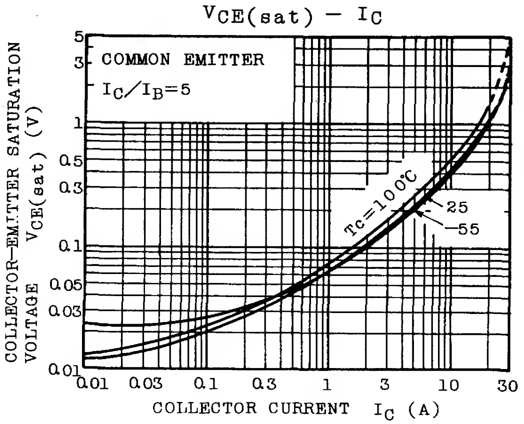
$I_C - V_{CE}$



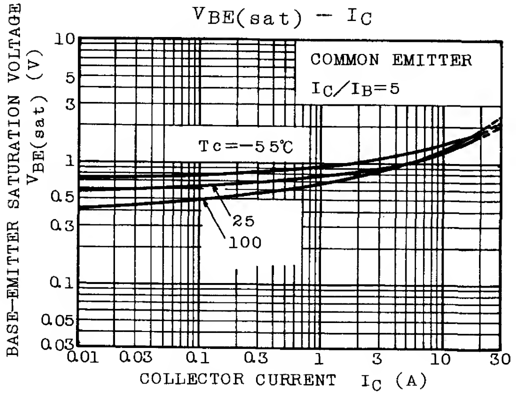
$I_C - V_{BE}$



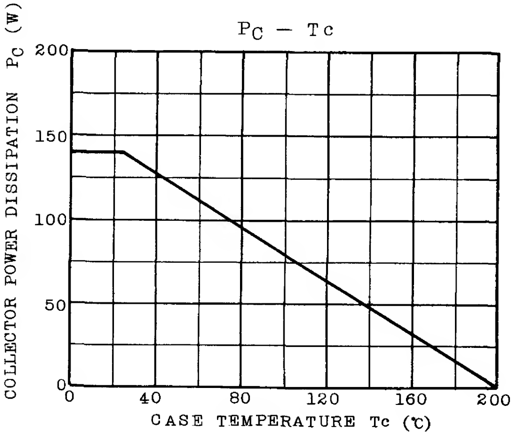
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Tc$

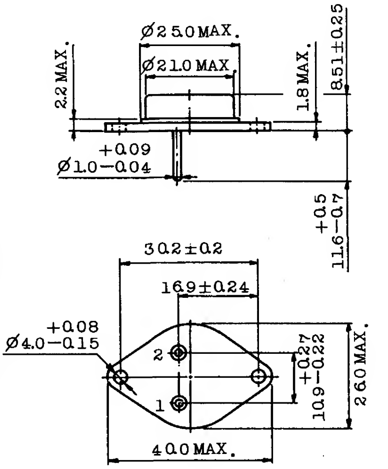
SILICON NPN TRIPLE DIFFUSED TYPE

2N5039

DC-DC CONVERTER, SWITCHING REGULATOR AND HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:
- Excellent Switching Times : $t_r < 0.5\mu s$, $t_f < 0.5\mu s$ @ $I_C=10A$, $I_B=1A$
- Low Saturation Voltage : $V_{CE(sat)} < 2.5V$ @ $I_C=20A$, $I_B=5A$

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

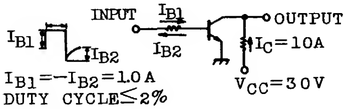
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS ($T_a=25°C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	120	V
Collector-Emitter Sustaining Voltage ($V_{BE}=-1.5V$, $R_{BE}=100\Omega$)		$V_{CEX(SUS)}$	120	V
* Emitter-Base Voltage		V_{EBO}	7	V
* Collector Current	DC	I_C	20	A
	Peak	I_{CM}	30	A
* Base Current		I_B	5	A
* Collector Power Dissipation ($T_c=25°C$) Derate Linearly 25°C		P_C	140	W
			0.8	W/°C
* Junction Temperature		T_j	200	°C
* Storage Temperature Range		T_{stg}	−65 ~ 200	°C

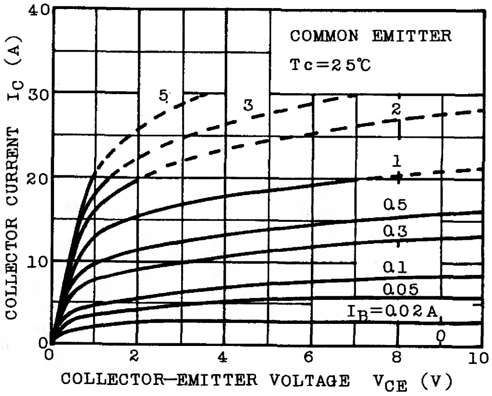
ELECTRICAL CHARACTERISTICS ($T_a=25°C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	$V_{CE}=110V$, $V_{BE}=-1.5V$	−	−	50	mA
* Collector Cut-off Current		I_{CEX}	$V_{CE}=85V$, $V_{BE}=-1.5V$, $T_c=150°C$	−	−	10	mA
* Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	−	−	15	mA
			$V_{EB}=7V$, $I_C=0$	−	−	50	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=0.2A$, $I_B=0$	75	−	−	V
* DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=2A$	30	−	250	
			$V_{CE}=5V$, $I_C=10A$	20	−	100	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=20A$, $I_B=5A$	−	−	2.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=20A$, $I_B=5A$	−	−	3.3	V
* Small Signal Forward Current Transfer Ratio		$\|h_{fe}\|$	$V_{CE}=10V$, $I_C=2A$, $f=5MHz$	12	−	−	
* Switching Time	Rise Time	t_r	 INPUT I_{B1} I_{B2} OUTPUT $I_C=10A$ $V_{CC}=30V$ $I_{B1}=-I_{B2}=1.0A$ DUTY CYCLE≤2%	−	−	0.5	μs
	Storage Time	t_{stg}		−	−	1.5	μs
	Fall Time	t_f		−	−	0.5	μs

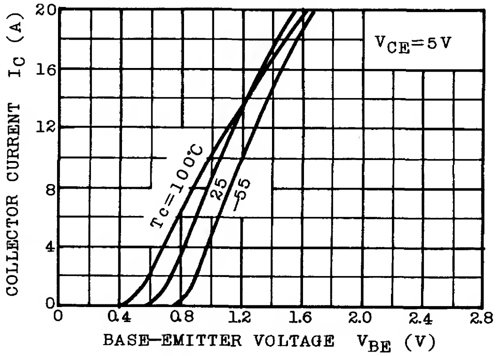
* In accordance with JEDEC registration data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

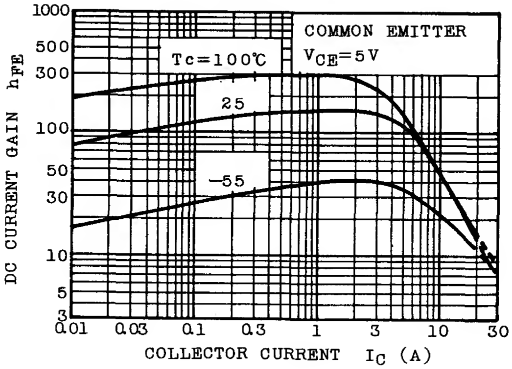
I_C — V_{CE}



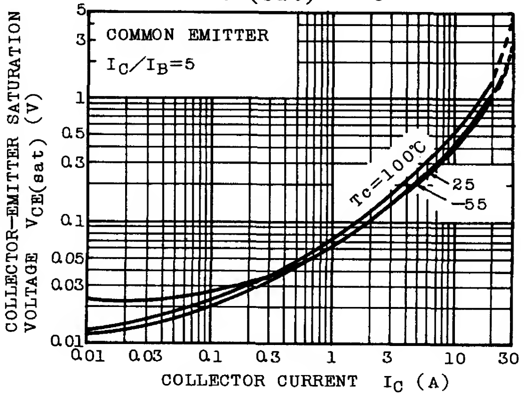
I_C — V_{BE}



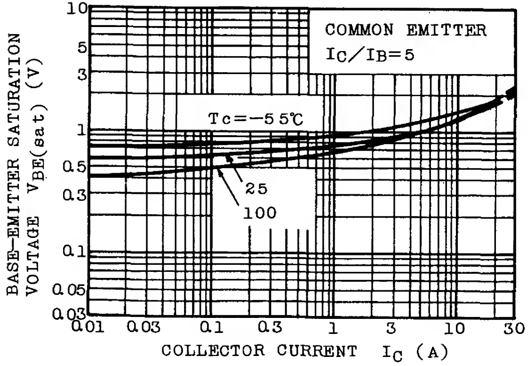
h_{FE} — I_C



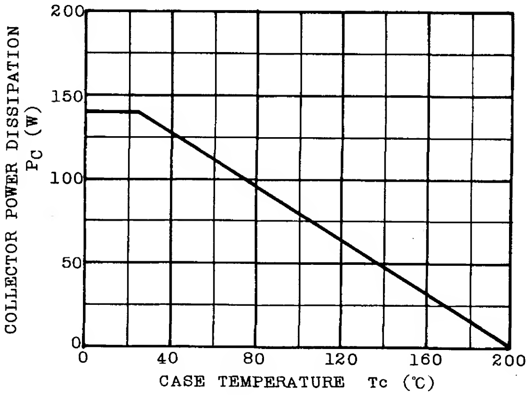
$V_{CE(sat)}$ — I_C



$V_{BE(sat)}$ — I_C



P_C — Tc



SILICON NPN TRIPLE DIFFUSED TYPE

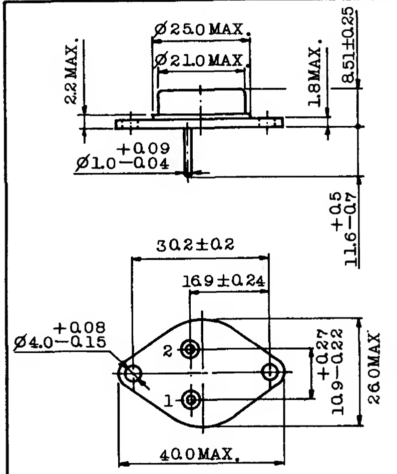
2N5301

HIGH POWER SWITCHING,AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
  h_{FE}=5.0 (Min.) @ V_{CE}=4.0V, I_C=30A
  $V_{CE(sat)}$=3.0V (Max.) @ I_C=30A, I_B=6A
- Low Saturation Voltage:
  $V_{CE(sat)}$=0.75V (Max.) @ I_C=10A, I_B=1.0A
  $V_{BE(sat)}$=1.7V (Max.) @ I_C=10A, I_B=1.0A
- High Collector Power Dissipation Capability:
  P_C=200W (Max.)
- Complementary to 2N4398

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	40	V
※	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	40	V
※	Emitter-Base Voltage		V_{EBO}	5	V
※	Collector Current	DC	I_C	30	A
		Peak	I_{CM}	50	A
※	Base Current		I_B	7.5	A
※	Collector Power Dissipation (Tc=25°C) Derate above 25°C		P_C	200 1.14	W W/°C
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65 ~ 200	°C

※In Accordance with JEDEC Registration Data format JS-6 RDF-2.

2N5301

ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※ Collector Cut-off Current		I_{CBO}	V_{CB}=40V, I_E=0	-	-	1.0	mA
※ Collector Cut-off Current		I_{CEX}	V_{CE}=40V, V_{BE}=-1.5V	-	-	1.0	mA
※ Collector Cut-off Current		I_{CEX}	V_{CE}=40V, V_{BE}=-1.5V, Tc=150°C	-	-	10	mA
※ Collector Cut-off Current		I_{CEO}	V_{CE}=40V, I_B=0	-	-	5.0	mA
※ Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	mA
※ Collector-Emitter Sustaining Voltage		※※ $V_{CEO(SUS)}$	I_C=200mA, I_B=0	40	-	-	V
※ DC Current Gain		h_{FE}	V_{CE}=2.0V, I_C=1.0A	40	-	-	
			V_{CE}=2.0V, I_C=15A	15	-	60	
			V_{CE}=4.0V, I_C=30A	5.0	-	-	
※ Base-Emitter Voltage		V_{BE}	V_{CE}=2.0V, I_C=15A	-	-	1.7	V
			V_{CE}=4.0V, I_C=30A	-	-	3.0	V
※ Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=1.0A	-	-	0.75	V
			I_C=20A, I_B=2.0A	-	-	2.0	V
			I_C=30A, I_B=6.0A	-	-	3.0	V
※ Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=1.0A	-	-	1.7	V
			I_C=15A, I_B=1.5A	-	-	1.8	V
			I_C=20A, I_B=2.0A	-	-	2.5	V
※ Transition Frequency		f_T	V_{CE}=10V, I_C=1.0A, f=1.0MHz	2.0	-	-	MHz
※ Small-Signal Current Gain		h_{fe}	V_{CE}=10V, I_C=1.0A, f=1.0kHz	40	-	-	
※ Switching Time	Rise Time	t_r	See Fig.1-1	-	-	1.0	μs
	Storage Time	t_{stg}	See Fig.1-2	-	-	2.0	μs
	Fall Time	t_f		-	-	1.0	μs

※In Accordance with JEDEC Registration Data Format JS-6 RDF-1.
※※The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

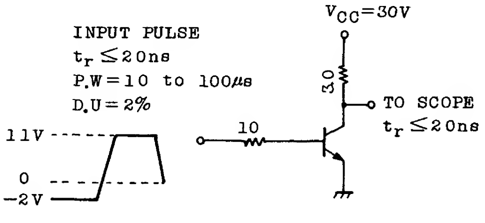
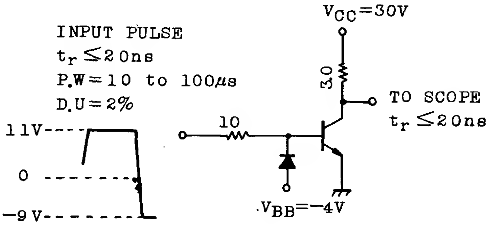
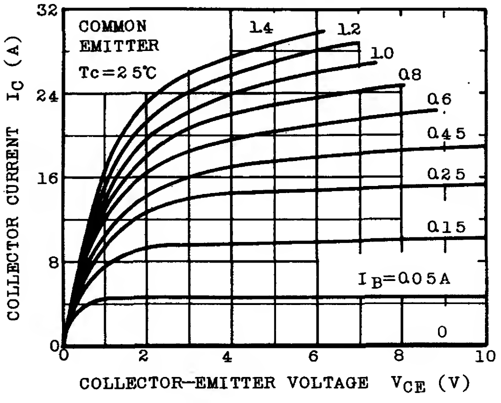


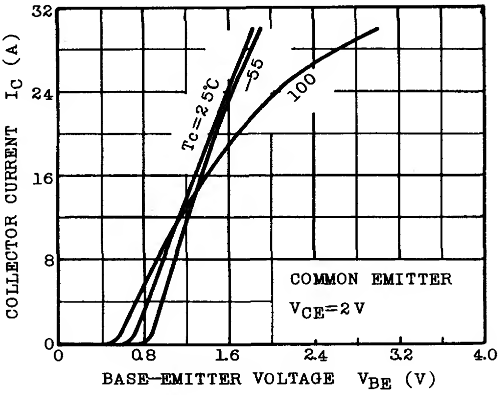
Fig.1-2 TURN-OFF TIME



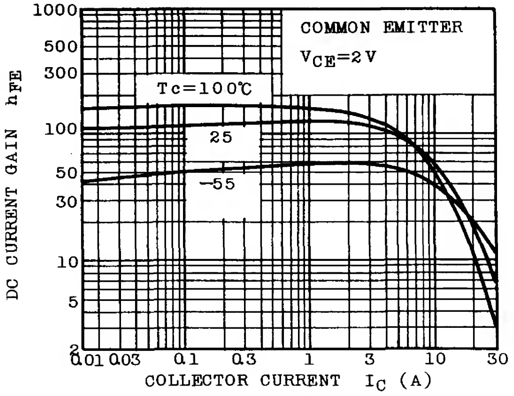
I_C – V_{CE}



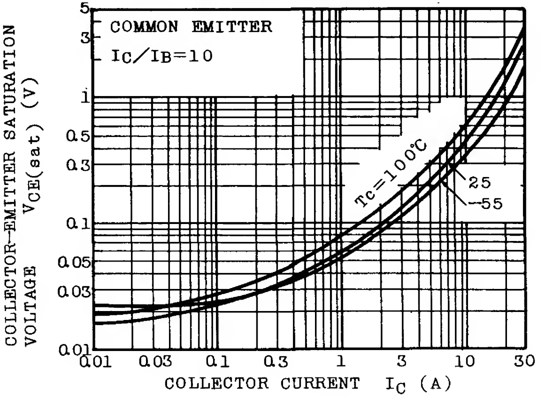
I_C – V_{BE}



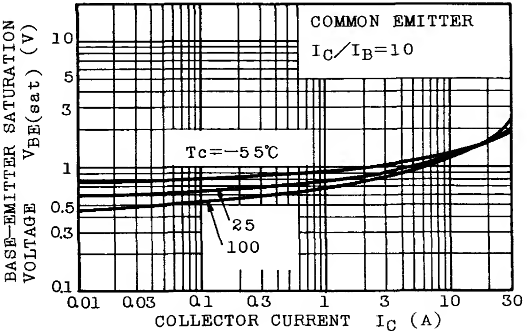
h_{FE} – I_C



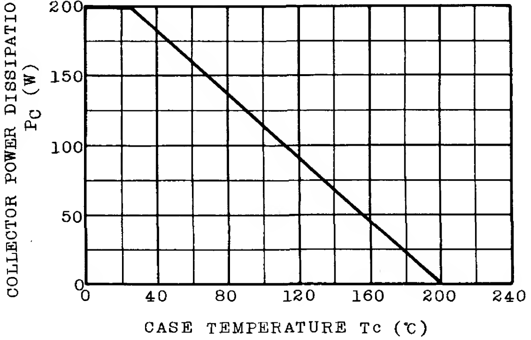
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



P_C – Tc



2N5302

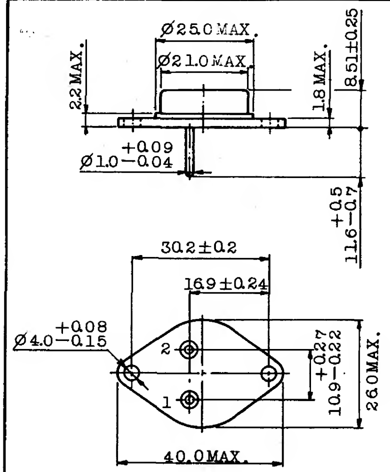
SILICON NPN TRIPLE DIFFUSED TYPE

HIGH POWER SWITCHING,AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
  - h_{FE}=5.0 (Min.) @ V_{CE}=4.0V, I_C=30A
  - $V_{CE(sat)}$=3.0V (Max.) @ I_C=30A, I_B=1.0A
- Low Saturation Voltage:
  - $V_{CE(sat)}$=0.75V (Max.) @ I_C=10A, I_B=1.0A
  - $V_{CE(sat)}$=1.7V (Max.) @ I_C=10A, I_B=1.0A
- High Collector Power Dissipation Capability:
  - P_C=200W (Max.)
- Complementary to 2N4399

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	60	V
※	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	60	V
※	Emitter-Base Voltage		V_{EBO}	5	V
※	Collector Current	DC	I_C	30	A
		Peak	I_{CM}	50	A
※	Base Current		I_B	7.5	A
※	Collector Power Dissipation (Tc=25°C)		P_C	200	W
	Derate above 25°C			1.14	W/°C
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65 ~ 200	°C

※In Accordance with JEDEC Registration Data format JS-6 RDF-2.

ELECTRICAL CHARACTERISTICS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current		I_{CBO}	V_{CB}=60V, I_E=0	-	-	1.0	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=60V, V_{BE}=-1.5V	-	-	1.0	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=60V, V_{BE}=-1.5V, Tc=150°C	-	-	10	mA
※	Collector Cut-off Current		I_{CEO}	V_{CE}=60V, I_B=0	-	-	5.0	mA
※	Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	mA
※	Collector-Emitter Sustaining Voltage		※※ $V_{CEO(SUS)}$	I_C=200mA, I_B=0	60	-	-	V
※	DC Current Gain		h_{FE}	V_{CE}=2.0V, I_C=1.0A	40	-	-	
				V_{CE}=2.0V, I_C=15A	15	-	60	
				V_{CE}=4.0V, I_C=30A	5.0	-	-	
※	Base-Emitter Voltage		V_{BE}	V_{CE}=2.0V, I_C=15A	-	-	1.7	V
				V_{CE}=4.0V, I_C=30A	-	-	3.0	V
※	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=1.0A	-	-	0.75	V
				I_C=20A, I_B=2.0A	-	-	2.0	V
				I_C=30A, I_B=6.0A	-	-	3.0	V
※	Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=1.0A	-	-	1.7	V
				I_C=15A, I_B=1.5A	-	-	1.8	V
				I_C=20A, I_B=2.0A	-	-	2.5	V
※	Transition Frequency		f_T	V_{CE}=10V, I_C=1.0A, f=1.0MHz	2.0	-	-	MHz
※	Small-Signal Current Gain		h_{fe}	V_{CE}=10V, I_C=1.0A, f=1.0kHz	40	-	-	
※	Switching Time	Rise Time	t_r	See Fig.1-1	-	-	1.0	μs
		Storage Time	t_{stg}	See Fig.1-2	-	-	2.0	μs
		Fall Time	t_f		-	-	1.0	μs

※In Accordance with JEDEC Registration Data Format JS-6 RDF-1.
※※The sustaining voltage VCEO(SUS)MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

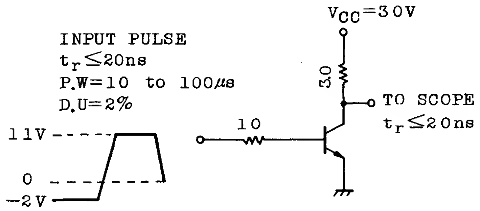
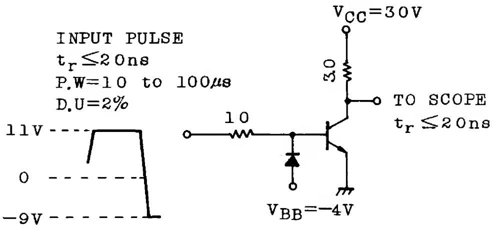
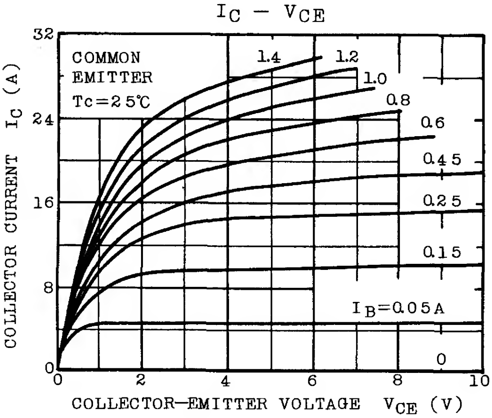
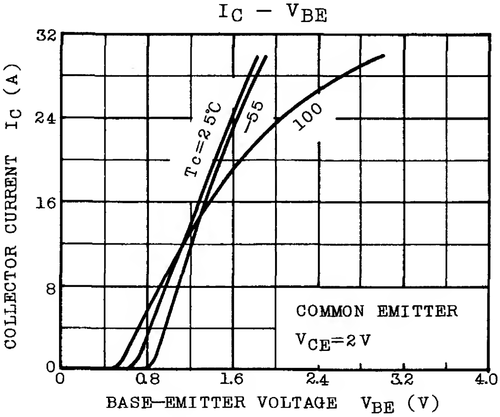
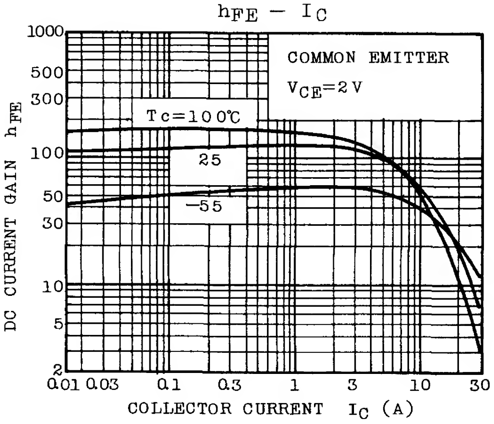


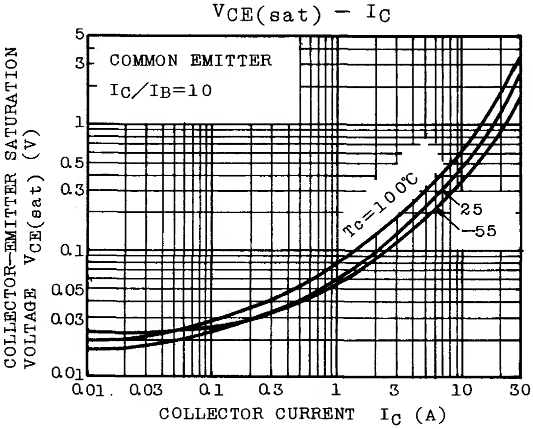
Fig.1-2 TURN-OFF TIME

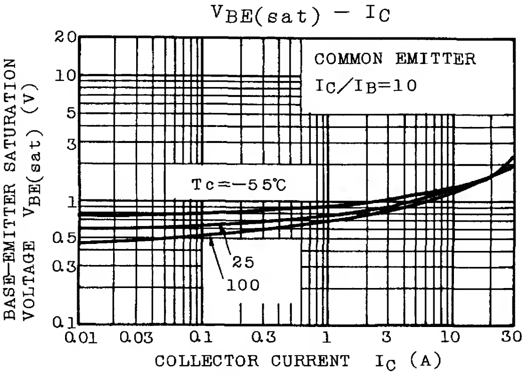


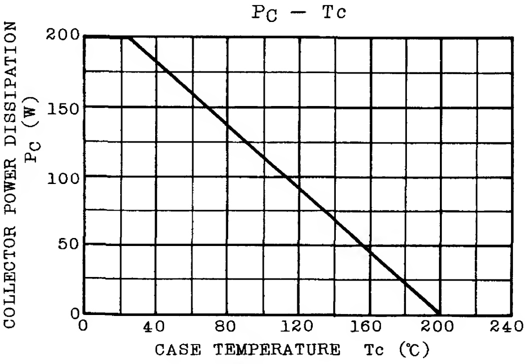

$I_C - V_{CE}$
COMMON
EMITTER
Tc=25℃
1.4
1.2
1.0
0.8
0.6
0.45
0.25
0.15
I_B=0.05A
0
COLLECTOR CURRENT I_C (A)
0
8
16
24
32
0
2
4
6
8
10
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)


$I_C - V_{BE}$
Tc=25℃
−55
100
COMMON EMITTER
V_{CE}=2V
COLLECTOR CURRENT I_C (A)
0
8
16
24
32
0
0.8
1.6
2.4
3.2
4.0
BASE–EMITTER VOLTAGE V_{BE} (V)


$h_{FE} - I_C$
COMMON EMITTER
V_{CE}=2V
Tc=100℃
25
−55
DC CURRENT GAIN h_{FE}
1000
500
300
100
50
30
10
5
2
0.01
0.03
0.1
0.3
1
3
10
30
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=10
Tc=100℃
25
−55
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.01
0.03
0.1
0.3
1
3
10
30
COLLECTOR CURRENT I_C (A)


$V_{BE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=10
Tc=−55℃
25
100
BASE–EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
20
10
5
3
1
0.5
0.3
0.1
0.01
0.03
0.1
0.3
1
3
10
30
COLLECTOR CURRENT I_C (A)


P_C − Tc
COLLECTOR POWER DISSIPATION P_C (W)
200
150
100
50
0
0
40
80
120
160
200
240
CASE TEMPERATURE Tc (℃)

SILICON NPN TRIPLE DIFFUSED TYPE

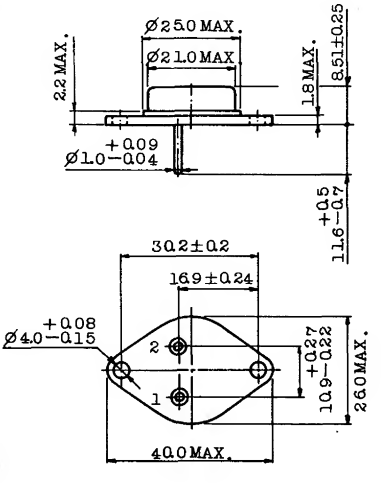
2N5303

HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- High Collector-Emitter Sustaining Voltage:
  $V_{CEO(SUS)}=80V$ (Min.) @ $I_C=200mA$, $I_B=0$
- Specification for h_{FE} and $V_{CE(sat)}$ Up to 20A:
  $h_{FE}=5.0$ (Min.) @ $V_{CE}=4.0V$, $I_C=20A$
  $V_{CE(sat)}=2.0V$ (Max.) @ $I_C=20A$, $I_B=4.0A$
- Low Saturation Voltage:
  $V_{CE(sat)}=0.75V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
  $V_{BE(sat)}=1.7V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
- High Collector Power Dissipation Capability:
  $P_C=200W$ (Max.)

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21D1A

Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage		V_{CBO}	80	V
※	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	80	V
※	Emitter-Base Voltage		V_{EBO}	5	V
※	Collector Current	DC	I_C	20	A
		Peak	I_{CM}	40	A
※	Base Current		I_B	7.5	A
※	Collector Power Dissipation ($T_c=25^{\circ}C$) Derate above 25°C		P_C	200 1.14	W W/°C
※	Junction Temperature		T_j	200	°C
※	Storage Temperature Range		T_{stg}	-65 ~200	°C

※In Accordance with JEDEC Registration Data format JS-6 RDG-2.

ELECTRICAL CHARACTERISTICS (Ta=25°C)

	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current		I_{CBO}	V_{CB}=80V, I_E=0	-	-	1.0	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=80V, V_{BE}=-1.5V	-	-	1.0	mA
※	Collector Cut-off Current		I_{CEX}	V_{CE}=80V, V_{BE}=-1.5V, Tc=150°C	-	-	10	mA
※	Collector Cut-off Current		I_{CEO}	V_{CE}=80V, I_B=0	-	-	5.0	mA
※	Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	5.0	mA
※	Collector-Emitter Sustaining Voltage		※※ $V_{CEO(SUS)}$	I_C=200mA, I_B=0	80	-	-	V
※	DC Current Gain		h_{FE}	V_{CE}=2.0V, I_C=1.0A	40	-	-	
				V_{CE}=2.0V, I_C=10A	15	-	60	
				V_{CE}=4.0V, I_C=20A	5.0	-	-	
※	Base-Emitter Voltage		V_{BE}	V_{CE}=2.0V, I_C=10A	-	-	1.5	V
				V_{CE}=4.0V, I_C=20A	-	-	2.5	V
※	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=1.0A	-	-	1.0	V
				I_C=15A, I_B=1.5A	-	-	1.5	V
				I_C=20A, I_B=4.0A	-	-	2.0	V
※	Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=1.0A	-	-	1.7	V
				I_C=15A, I_B=1.5A	-	-	2.0	V
				I_C=20A, I_B=4.0A	-	-	2.5	V
※	Transition Frequency		f_T	V_{CE}=10V, I_C=1.0A, f=1.0MHz	2.0	-	-	MHz
※	Small-Signal Current Gain		h_{fe}	V_{CE}=10V, I_C=1.0A, f=1.0kHz	40	-	-	
※	Switching Time	Rise Time	t_r	See Fig.1-1	-	-	1.0	μs
		Storage Time	t_{stg}	See Fig.1-2	-	-	2.0	μs
		Fall Time	t_f		-	-	1.0	μs

※In Accordance with JEDEC Registration Data Format JS-6 RDF-1.

※※The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Fig.1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

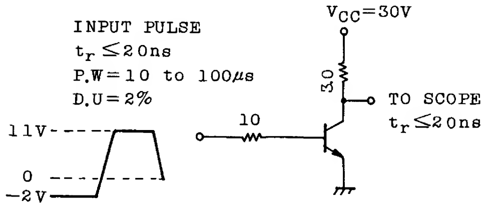
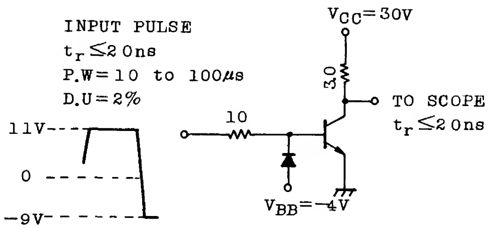
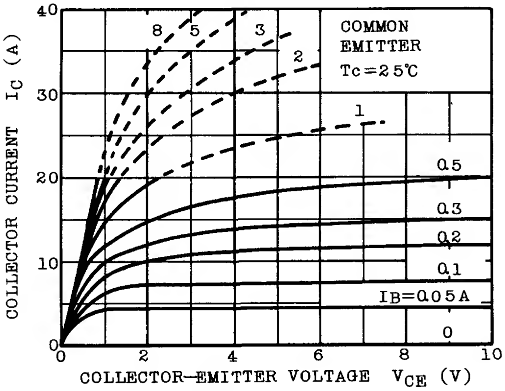
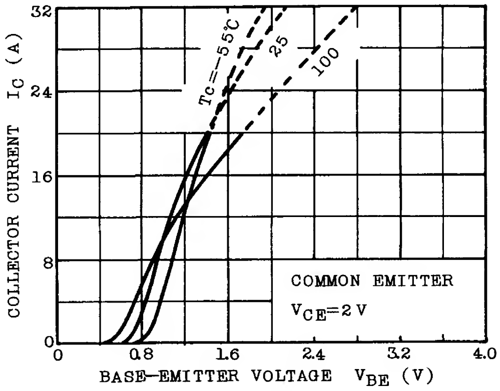


Fig.1-2 TURN-OFF TIME

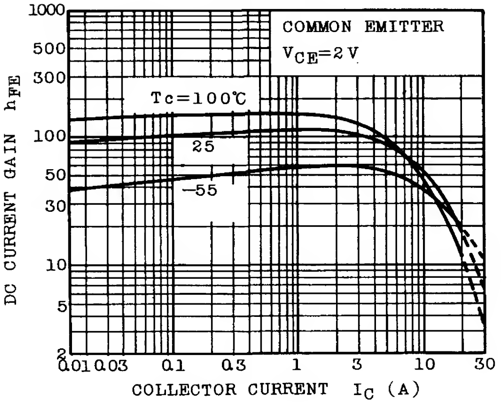




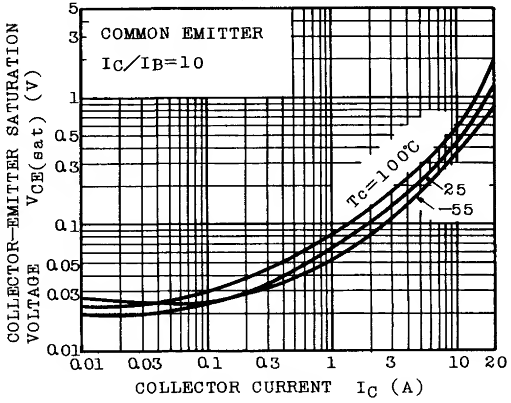
$I_C - V_{CE}$



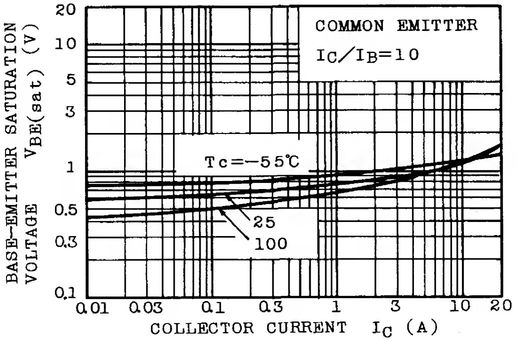
$I_C - V_{BE}$



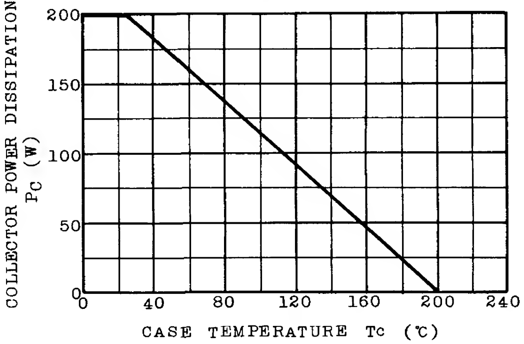
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - T_c$

2N6249

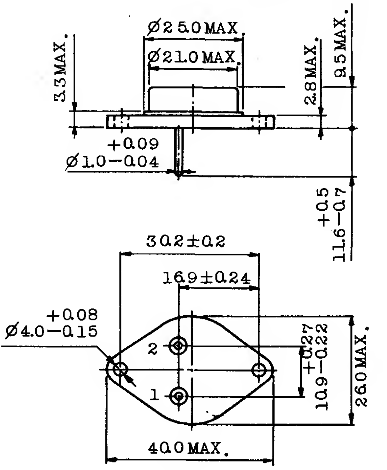
SILICON NPN TRIPLE DIFFUSED TYPE

HIGH POWER AMPLIFIER, POWER SWITCHING AND DC-DC CONVERTER APPLICATIONS.

FEATURES:

- High Collector-Emitter Sustaining Voltage
  : $V_{CEO(SUS)}=200V$ (Min.)
- Low Saturation Voltage : $V_{CE(sat)}<1.5V$
  @ $I_C=10A$, $I_B=1A$
- Excellent Switching Times : $t_r<2.0\mu s$, $t_f<1.0\mu s$
  @ $I_C=10A$, $I_B=\pm1A$
- High Collector Power Dissipation Capacity
  : $P_C=175W$ (Max.)
- Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

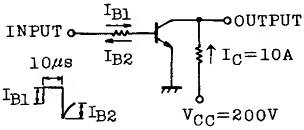
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Weight : 15.8g

MAXIMUM RATINGS ($T_a=25°C$)

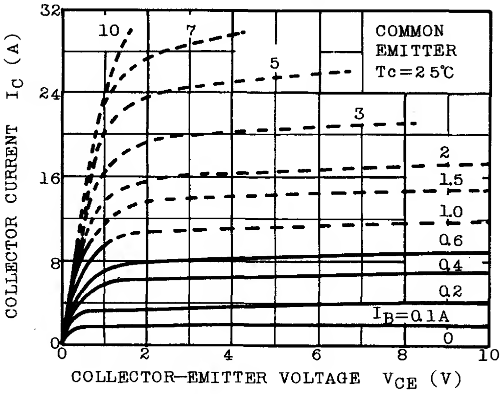
	CHARACTERISTIC		SYMBOL	RATING	UNIT
*	Collector-Base Voltage		V_{CBO}	300	V
	Collector-Emitter Sustaining Voltage ($R_{BE}=50\Omega$)		$V_{CER(SUS)}$	225	V
*	Collector-Emitter Sustaining Voltage ($V_{BE}=0$)		$V_{CEX(SUS)}$	225	V
	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	200	V
*	Emitter-Base Voltage		V_{EBO}	6	V
*	Collector Current	DC	I_C	10	A
		Peak	I_{CM}	30	A
*	Base Current		I_B	10	A
*	Collector Power Dissipation	$T_c=25°C$	P_C	175	W
		$T_c=100°C$		100	W
	Derate Linearly above 25°C			1.0	W/°C
*	Junction Temperature		T_j	200	°C
*	Storage Temperature Range		T_{stg}	-65 ~ 200	°C
*	Lead Temperature (0.8mm from case for 10s)		T_L	230	°C

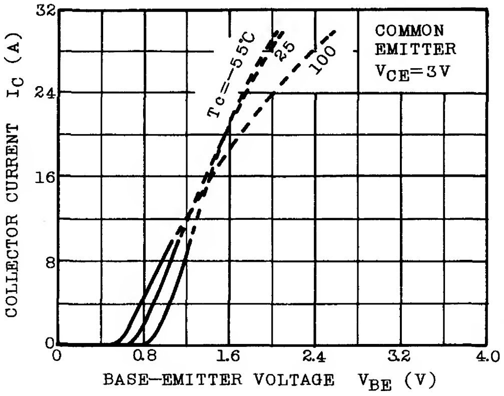
ELECTRICAL CHARACTERISTICS (Ta=25°C)

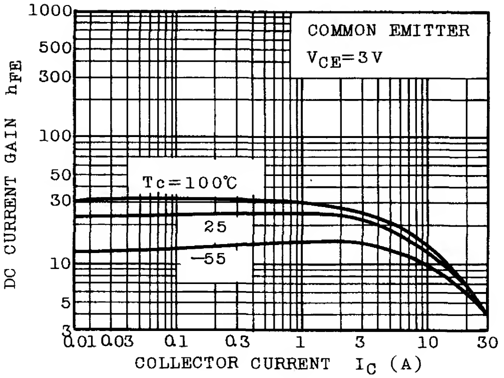
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEV}	V_{CE}=225V, V_{BE}=-1.5V	-	-	5	mA
*	Collector Cut-off Current		I_{CEV}	V_{CE}=225V, V_{BE}=-1.5V Tc=125°C	-	-	10	mA
	Collector Cut-off Current		I_{CEO}	V_{CE}=150V, I_B=0	-	-	5	mA
*	Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	1	mA
*	Collector-Emitter Sustaining Voltage		$V_{CER(SUS)}$**	I_C=0.2A, R_{BE}=50Ω	225	-	-	V
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$**	I_C=0.2A, I_B=0	200	-	-	V
*	Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	6	-	-	V
*	DC Current Gain		h_{FE}	V_{CE}=3V, I_C=10A	10	-	50	
*	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=10A, I_B=1A	-	-	1.5	V
		Base-Emitter	$V_{BE(sat)}$	I_C=10A, I_B=1A	-	-	2.25	V
*	Small Signal Current Gain		$\lvert h_{fe} \rvert$	V_{CE}=10V, I_C=1A f=1MHz	2.5	-	-	
*	Switching Time	Rise Time	t_r	 INPUT I_{B1} I_{B2} OUTPUT I_C=10A 10μs I_{B1} I_{B2} V_{CC}=200V I_{B1}=-I_{B2}=1A DUTY CYCLE≤2%	-	-	2.0	μs
		Storage Time	t_{stg}		-	-	3.5	μs
		Fall Time	t_f		-	-	1.0	μs
*	Second Breakdwon Collector Current (Base Forward Bias)		$I_{s/b}$	V_{CE}=30V, t=1s (non-repetitive)	5.8	-	-	A
*	Second Breakdown Energy (Base Reverse Bias)		$E_{s/b}$	I_C=10A, V_{BE}=-4V, L=50μH	2.5	-	-	mJ

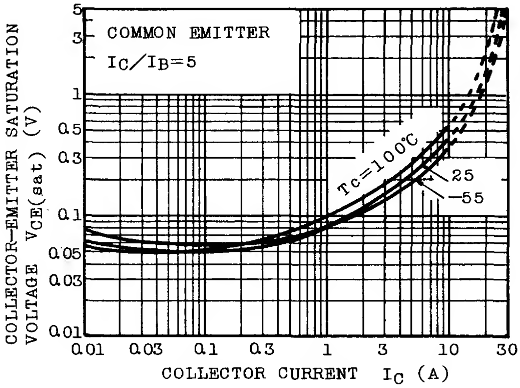
* In accordance with JEDEC registration data.

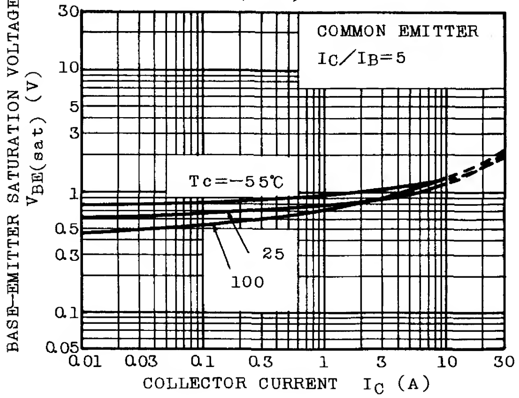
** The sustaining voltages $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

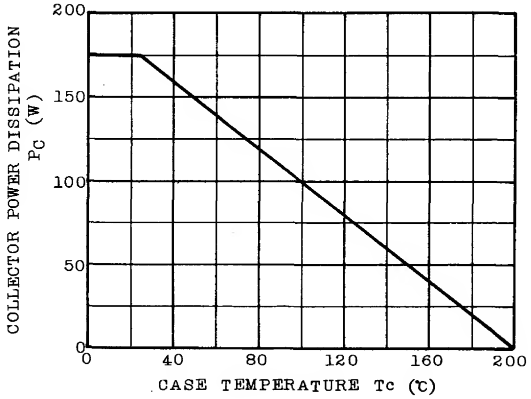

I_C – V_{CE}


I_C – V_{BE}


h_{FE} – I_C


$V_{CE(sat)}$ – I_C


$V_{BE(sat)}$ – I_C


P_C – T_c

SILICON NPN TRIPLE DIFFUSED TYPE

2N6250

DC-DC CONVERTER, SWITCHING REGULATOR AND HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

. High Collector-Emitter Sustaining Voltage
: $V_{CEO(SUS)}=275V$ (Min.)

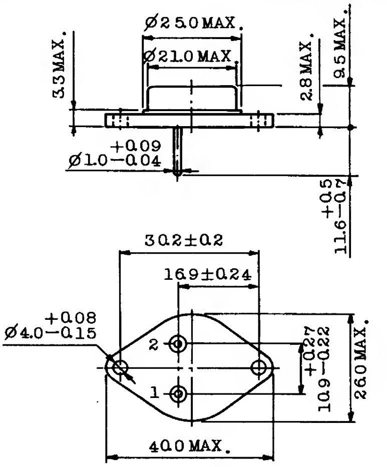
. Low Saturation Voltage : $V_{CE(sat)}<1.5V$
@ $I_C=10A$, $I_B=1.25A$

. Excellent Switching Times : $t_r<2.0\mu s$, $t_f<1.0\mu s$
@ $I_C=10A$, $I_B=\pm1.25A$

. High Collector Power Dissipation Capacity
: $P_C=175W$ (Max.)

. Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

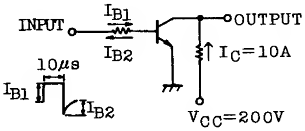
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Weight : 15.8g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

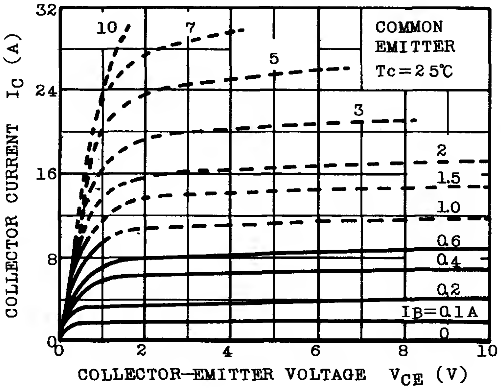
	CHARACTERISTIC		SYMBOL	RATING	UNIT
*	Collector-Base Voltage		V_{CBO}	375	V
	Collector-Emitter Sustaining Voltage ($R_{BE}=50\Omega$)		$V_{CER(SUS)}$	300	V
*	Collector-Emitter Sustaining Voltage ($V_{BE}=0$)		$V_{CEX(SUS)}$	300	V
	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	275	V
*	Emitter-Base Voltage		V_{EBO}	6	V
*	Collector Current	DC	I_C	10	A
		Peak	I_{CM}	30	A
*	Base Current		I_B	10	A
*	Collector Power Dissipation	$Tc=25^{\circ}C$	P_C	175	W
		$Tc=100^{\circ}C$		100	W
	Derate Linearly above 25°C			1.0	W/°C
*	Junction Temperature		T_j	200	°C
*	Storage Temperature Range		T_{stg}	-65 ~ 200	°C
*	Lead Temperature (0.8mm from case for 10s)		T_L	230	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

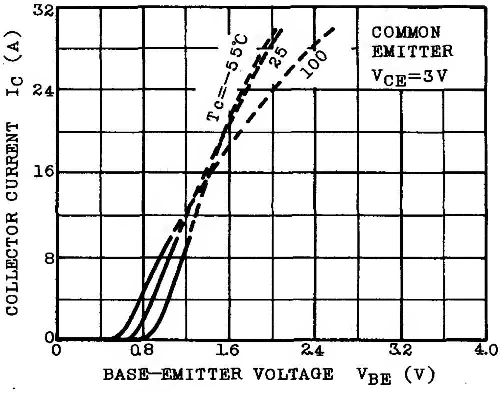
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEV}	V_{CE}=300V, V_{BE}=-1.5V	-	-	5	mA
*	Collector Cut-off Current		I_{CEV}	V_{CE}=300V, V_{BE}=-1.5V Tc=125°C	-	-	10	mA
	Collector Cut-off Current		I_{CEO}	V_{CE}=225V, I_B=0	-	-	5	mA
*	Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	1	mA
*	Collector-Emitter Sustaining Voltage		$V_{CER(SUS)}$**	I_C=0.2A, R_{BE}=50Ω	300	-	-	V
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$**	I_C=0.2A, I_B=0	275	-	-	V
*	Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	6	-	-	V
*	DC Current Gain		h_{FE}	V_{CE}=3V, I_C=10A	8	-	50	
*	Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=10A, I_B=1.25A	-	-	1.5	V
		Base-Emitter	$V_{BE(sat)}$	I_C=10A, I_B=1.25A	-	-	2.25	V
*	Small Signal Current Gain		$\|h_{fe}\|$	V_{CE}=10V, I_C=1A f=1MHz	2.5	-	-	
*	Switching Time	Rise Time	t_r	 INPUT I_{B1} I_{B2} OUTPUT I_C=10A 10μs I_{B1} I_{B2} V_{CC}=200V I_{B1}=$-I_{B2}$=1.25A DUTY CYCLE≦2%	-	-	2.0	μs
		Storage Time	ts		-	-	3.5	μs
		Fall Time	tf		-	-	1.0	μs
*	Second Breakdown Collecotr Current (Base Forward Bias)		$I_{s/b}$	V_{CE}=30V, t=1s (non-repetitive)	5.8	-	-	A
*	Second Breakdown Energy (Base Reverse Bias)		$E_{s/b}$	I_C=10A, V_{BE}=-4V L=50μH	2.5	-	-	mJ

* In accodance with JEDEC registration data.

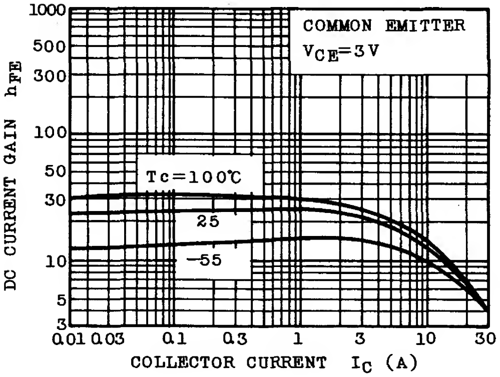
** The sustaining voltages $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



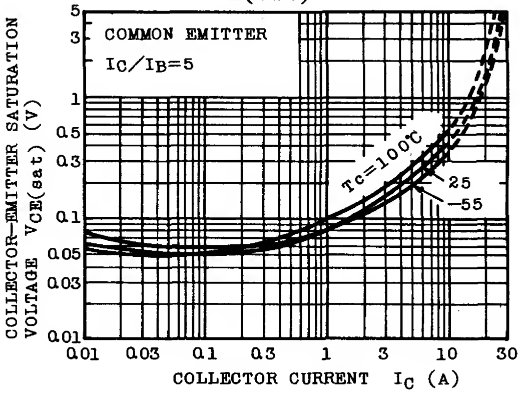
$I_C - V_{CE}$



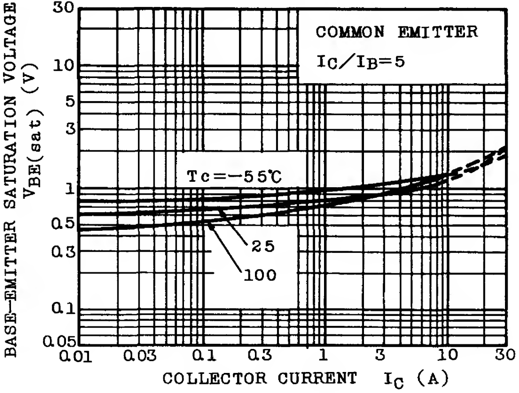
$I_C - V_{BE}$



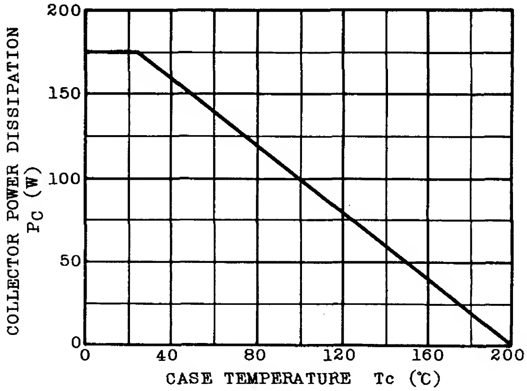
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - T_c$

2N6251

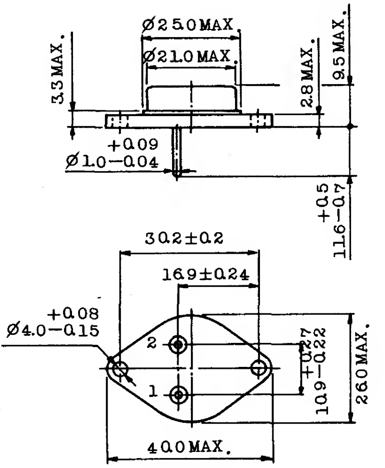
SILICON NPN TRIPLE DIFFUSED TYPE

DC-DC CONVERTER, SWITCHING REGULATOR
AND HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector-Emitter Sustaining Voltage
  : $V_{CEO(SUS)}=350V$ (Min.)
- Low Saturation Voltage : $V_{CE(sat)} < 1.5V$
  @ $I_C=10A$, $I_B=1.67A$
- Excellent Switching Times : $t_r < 2.0\mu s$, $t_f < 1.0\mu s$
  @ $I_C=10A$, $I_B=\pm1.67A$
- High Collector Power Dissipation Capacity
  : $P_C=175W$ (Max.)
- Excellent Area of Safe Operatings

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

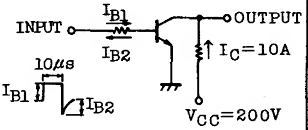
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Weight : 15.8g

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	450	V
Collector-Emitter Sustaining Voltage ($R_{BE}=50\Omega$)		$V_{CER(SUS)}$	375	V
* Collector-Emitter Sustaining Voltage ($V_{BE}=0$)		$V_{CEX(SUS)}$	375	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	350	V
* Emitter-Base Voltage		V_{EBO}	6	V
* Collector Current	DC	I_C	10	A
	Peak	I_{CM}	30	A
* Base Current		I_B	10	A
* Collector Power Dissipation	$Tc=25^{\circ}C$	P_C	175	W
	$Tc=100^{\circ}C$		100	W
Derate Linearly above 25°C			1.0	W/°C
* Junction Temperature		T_j	200	°C
* Storage Temperature Range		T_{stg}	−65 ~ 200	°C
* Lead Temperature (0.8mm from case for 10s)		T_L	230	°C

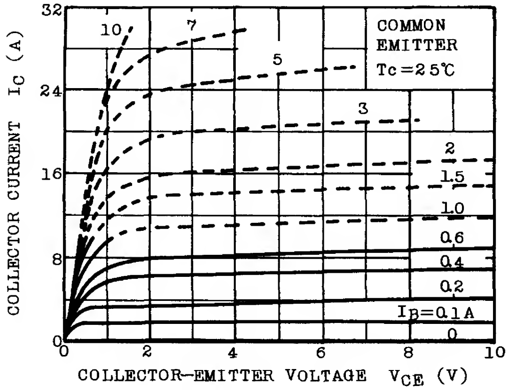
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEV}	V_{CE}=375V, V_{BE}=-1.5V	-	-	5	mA
* Collector Cut-off Current		I_{CEV}	V_{CE}=375V, V_{BE}=-1.5V Tc=125°C	-	-	10	mA
Collector Cut-off Current		I_{CEO}	V_{CE}=300V, I_B=0	-	-	5	mA
* Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	1	mA
* Collector-Emitter Sustaining Voltage		$V_{CER(SUS)}$ **	I_C=0.2A, R_{BE}=50Ω	375	-	-	V
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=0.2A, I_B=0	350	-	-	V
* Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	6	-	-	V
* DC Current Gain		h_{FE}	V_{CE}=3V, I_C=10A	6	-	50	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	I_C=10A, I_B=1.67A	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	I_C=10A, I_B=1.67A	-	-	2.25	V
* Small Signal Current Gain		h_{fe}	V_{CE}=10V, I_C=1A f=1MHz	2.5	-	-	
* Switching Time	Rise Time	t_r	 INPUT I_{B1} I_{B2} OUTPUT I_C=10A 10µs I_{B1} I_{B2} V_{CC}=200V IB_1=$-I_{B2}$=1.67A DUTY CYCLE≦2%	-	-	2.0	µs
	Storage Time	t_s		-	-	3.5	µs
	Fall Time	t_f		-	-	1.0	µs
* Second Breakdown Collector Current (Base Forward Bias)		$I_{s/b}$	V_{CE}=30V, t=1s (non-repetitive)	5.8	-	-	A
* Second Breakdwon Energy (Base Reverse Bias)		$E_{s/b}$	I_C=10A, V_{BE}=-4V L=50µH	2.5	-	-	mJ

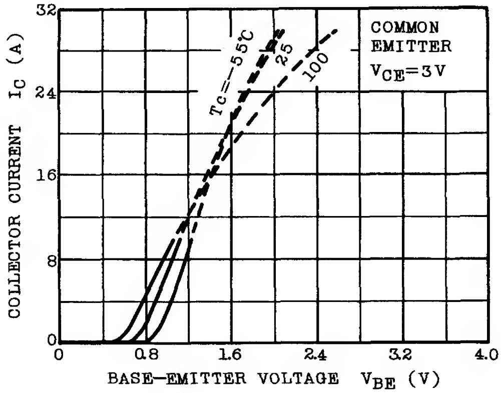
* In accordance with JEDEC registration data.

** The sustaining voltages $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured a curve tracer.

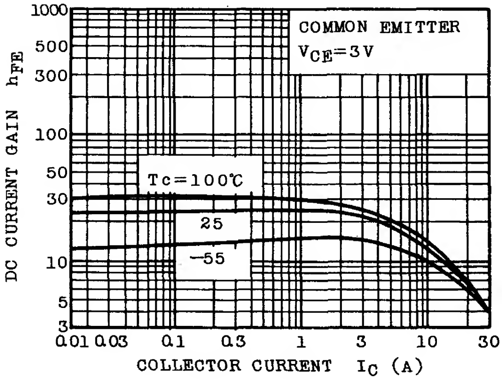
$I_C - V_{CE}$



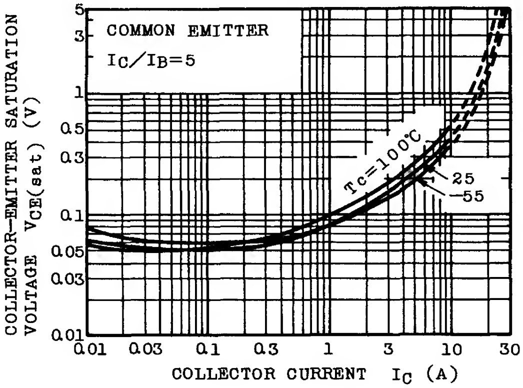
$I_C - V_{BE}$



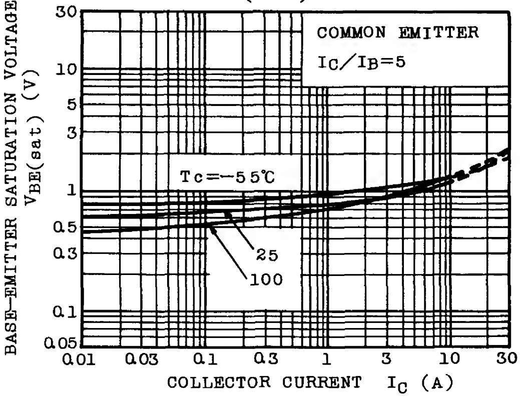
$h_{FE} - I_C$



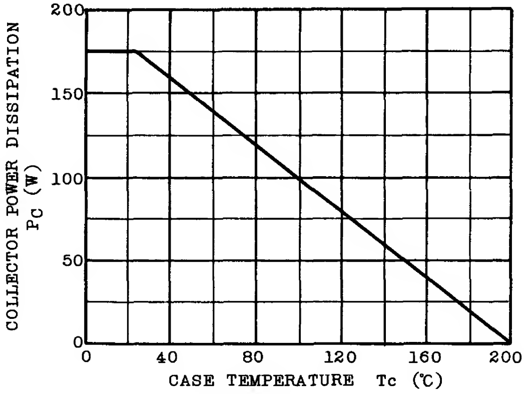
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



$P_C - Tc$



SILICON NPN TRIPLE DIFFUSED TYPE

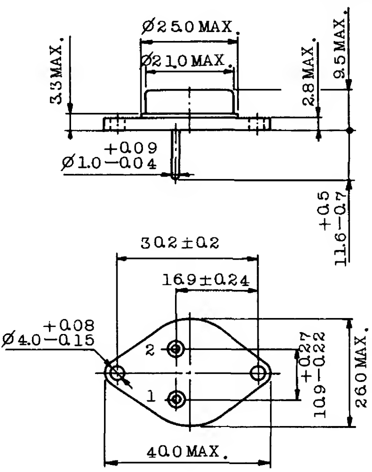
2N6546

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER, RELAY AND SOLENOID DRIVER APPLICATIONS.

FEATURES:

- High Sustaining Voltage : $V_{CEO(SUS)}$=300V (Min.)
- High Collector Current : I_C=15A (Max.)
- Excellent Switching Times

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

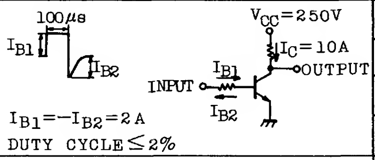
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Weight : 15.8g

MAXIMUM RATINGS (T_a=25°C)

	CHARACTERISTIC		SYMBOL	RATING	UNIT
	Collector-Base Voltage		V_{CBO}	650	V
*	Collector-Emitter Voltage		V_{CEV}	650	V
*	Collector-Emitter Sustaining Voltage		$V_{CEX(SUS)}$	350	V
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	300	V
*	Emitter-Base Voltage		V_{EBO}	9	V
*	Collector Current	DC	I_C	15	A
		Peak	I_{CM}	30	A
*	Base Current		I_B	10	A
*	Emitter Current		I_E	− 25	A
*	Collector Power Dissipation	T_c=25°C	P_C	175	W
		T_c=100°C		100	W
	Derate Linearly above 25°C			1	W/°C
*	Junction Temperature		T_j	200	°C
*	Storage Temperature Range		T_{stg}	-65 ~ 200	°C
*	Thermal Resistance		θ_{jc}	1	°C/W
*	Lead Temperature (3.17mm from case for 5s)		T_L	275	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

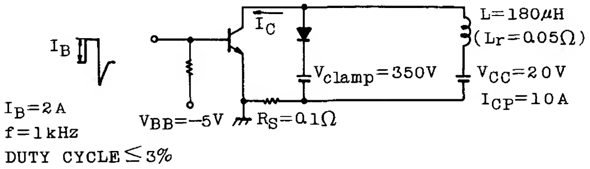
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current		I_{CEV}	V_{CE}=650V, V_{BE}=-1.5V	-	-	1	mA
*	Collector Cut-off Current		I_{CEV}	V_{CE}=650V, V_{BE}=-1.5V; Tc=100°C	-	-	4	mA
*	Collector Cut-off Current		I_{CER}	V_{CE}=650V, R_{BE}=50Ω, Tc=100°C	-	-	5	mA
*	Emitter Cut-off Current		I_{EBO}	V_{EB}=9V, I_C=0	-	-	1	mA
*	Collector-Emitter Sustaining Voltage (Note:1)		$V_{CEX(SUS)}$ **	I_C=8A, V_{clamp}=350V, Tc=100°C	350	-	-	V
				I_C=15A, V_{clamp}=200V, Tc=100°C	200	-	-	V
*	Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=0.1A, I_B=0	300	-	-	V
*	DC Current Gain		h_{FE}	V_{CE}=2V, I_C=5A	12	-	60	
				V_{CE}=2V, I_C=10A	6	-	30	
*	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=2A	-	-	1.5	V
				I_C=15A, I_B=3A	-	-	5	V
				I_C=10A, I_B=2A, Tc=100°C	-	-	2.5	V
*	Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=2A	-	-	1.6	V
				I_C=10A, I_B=2A, Tc=100°C	-	-	1.6	V
*	Transition Frequency		f_T	V_{CE}=10V, I_C=0.5A, f=1MHz	6	-	28	MHz
*	Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	125	-	500	pF
*	Switching Time	Delay Time	td	 100μs I_{B1} I_{B2} V_{CC}=250V I_C=10A OUTPUT INPUT I_{B1} I_{B2} I_{B1}=−I_{B2}=2A DUTY CYCLE≦2%	-	-	0.05	μs
		Rise Time	tr		-	-	1.0	μs
		Storage Time	tstg		-	-	4.0	μs
		Fall Time	tf		-	-	0.7	μs
		Storage Time	tstg	See Fig.1 Tc=100°C	-	-	5.0	μs
		Fall Time	tf		-	-	1.5	μs
*	Second Breakdown Collector Current(Base forward biased)		$I_{s/b}$	V_{CE}=100V, t=1s (non repetitive)	0.2	-	-	A

* In Accordance with JEDEC Registration Data.

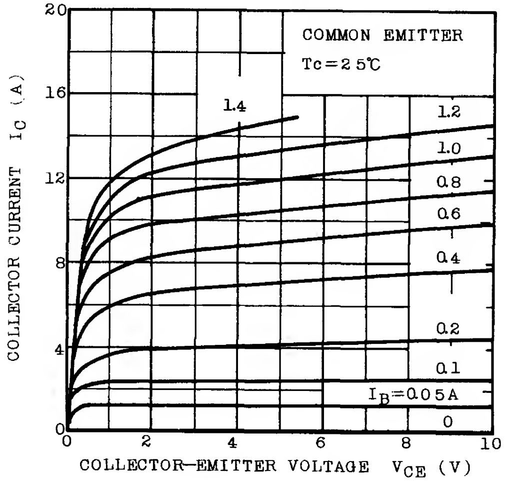
** The sustaining voltages $V_{CEX(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Note 1 : Test condition V_{CC}=20V, L=180μH, (L_r=0.05Ω)

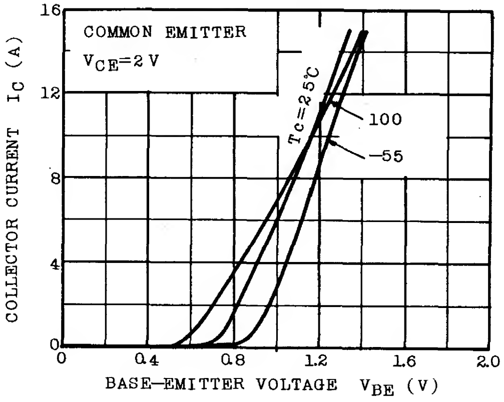
Fig.1 : Inductive Load Switching Time Test Circuit.



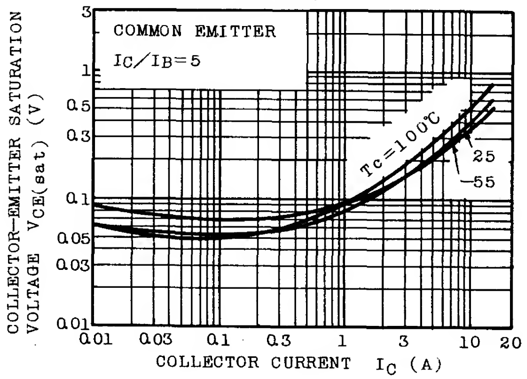
$I_C - V_{CE}$



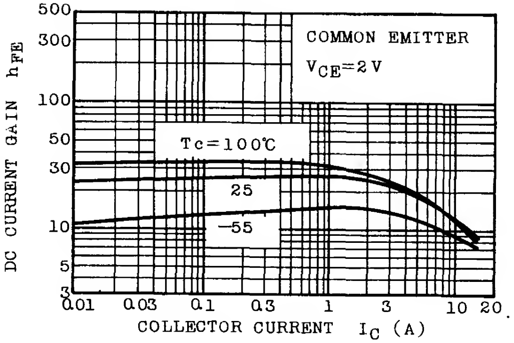
$I_C - V_{BE}$



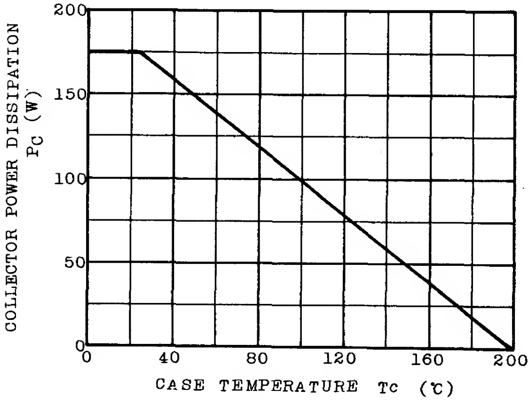
$V_{CE(sat)} - I_C$



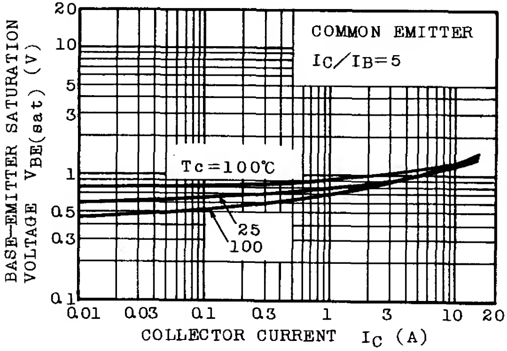
$h_{FE} - I_C$



$P_C - T_C$



$V_{BE(sat)} - I_C$



2N6547

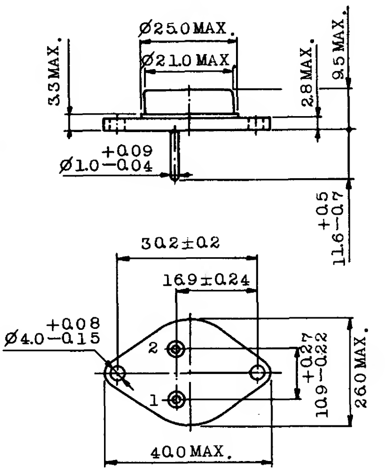
SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER, RELAY AND SOLENOID DRIVER APPLICATIONS.

FEATURES:

- High Sustaining Voltage : $V_{CEO(SUS)}$=400V (Min.)
- High Collector Current : I_C=15A (Max.)
- Excellent Switching Times

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

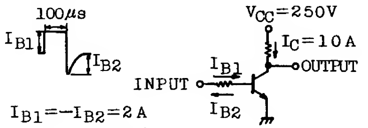
JEDEC	TO−204MA/TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21E1A

Weight : 15.8g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	850	V
* Collector-Emitter Voltage		V_{CEV}	850	V
* Collector-Emitter Sustaining Voltage		$V_{CEX(SUS)}$	450	V
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	400	V
* Emitter-Base Voltage		V_{EBO}	9	V
* Collector Current	DC	I_C	15	A
	Peak	I_{CM}	30	A
* Base Current		I_B	10	A
* Emitter Current		I_E	- 25	A
* Collector Power Dissipation	Tc=25°C	P_C	175	W
	Tc=100°C		100	W
Derate Linearly above 25°C			1	W/°C
* Junction Temperature		T_j	200	°C
* Storage Temperature Range		T_{stg}	-65 ~ 200	°C
* Thermal Resistance		θ_{jc}	1	°C/W
* Lead Temperature (3.17mm from case for 5s)		T_L	275	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

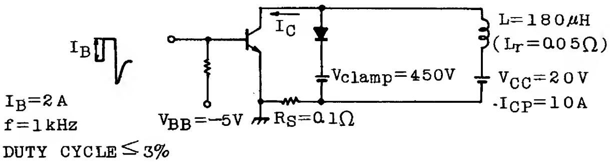
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEV}	V_{CE}=850V, V_{BE}=-1.5V	-	-	1	mA
* Collector Cut-off Current		I_{CEV}	V_{CE}=850V, V_{BE}=-1.5V, Tc=100°C	-	-	4	mA
* Collector Cut-off Current		I_{CER}	V_{CE}=850V, R_{BE}=50Ω, Tc=100°C	-	-	5	mA
* Emitter Cut-off Current		I_{EBO}	V_{EB}=9V, I_C=0	-	-	1	mA
* Collector-Emitter Sustaining Voltage (Note:1)		$V_{CEX(SUS)}$ **	I_C=8A, V_{clamp}=450V, Tc=100°C	450	-	-	V
			I_C=15A, V_{clamp}=300V, Tc=100°C	300	-	-	V
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	I_C=0.1A, I_B=0	400	-	-	V
* DC Current Gain		h_{FE}	V_{CE}=2V, I_C=5A	12	-	60	
			V_{CE}=2V, I_C=10A	6	-	30	
* Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=10A, I_B=2A	-	-	1.5	V
			I_C=15A, I_B=3A	-	-	5	V
			I_C=10A, I_B=2A, Tc=100°C	-	-	2.5	V
* Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=10A, I_B=2A	-	-	1.6	V
			I_C=10A, I_B=2A, Tc=100°C	-	-	1.6	V
* Transition Frequency		f_T	V_{CE}=10V, I_C=0.5A, f=1MHz	6	-	28	MHz
* Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	125	-	500	pF
* Switching Time	Delay Time	td	 100μs I_{B1} I_{B2} V_{CC}=250V I_C=10A OUTPUT INPUT I_{B1} I_{B2} I_{B1}=−I_{B2}=2A DUTY CYCLE≦2%	-	-	0.05	μs
	Rise Time	tr		-	-	1.0	μs
	Storage Time	tstg		-	-	4.0	μs
	Fall Time	tf		-	-	0.7	μs
	Storage Time	tstg	See Fig.1 Tc=100°C	-	-	5.0	μs
	Fall Time	tf		-	-	1.5	μs
* Second Breakdown Collector Current (Base forward biased)		$I_{s/b}$	V_{CE}=100V, t=1s (non repetitive)	0.2	-	-	A

* In Accordance with JEDEC Registration Data.

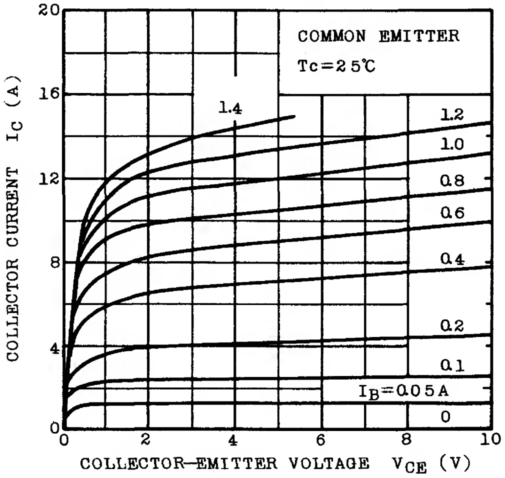
** The sustaining voltages $V_{CEX(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Note.1 : Test condition V_{CC}=20V, L=180μH (L_r=0.05Ω)

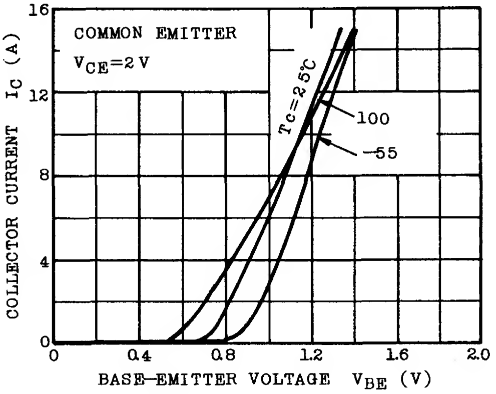
Fig. 1 : Inductive Load Switching Time Test Circuit



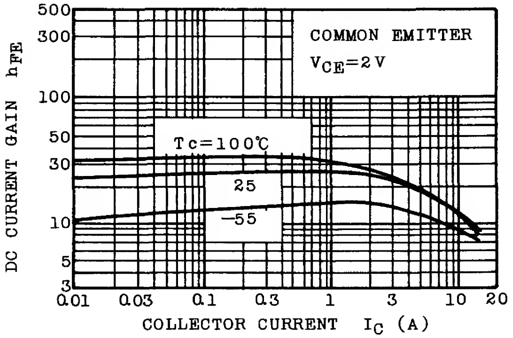
I_C – V_{CE}



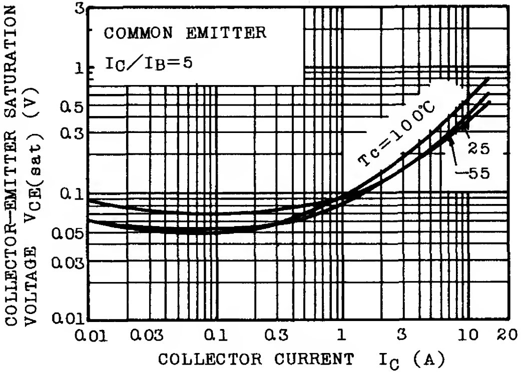
I_C – V_{BE}



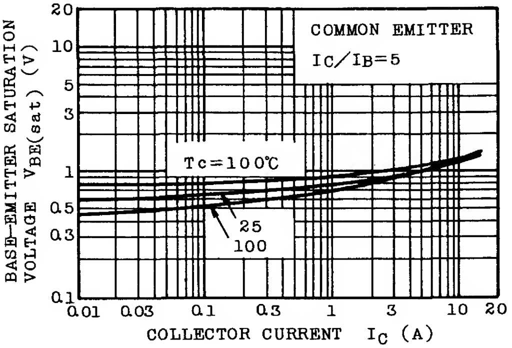
h_{FE} – I_C



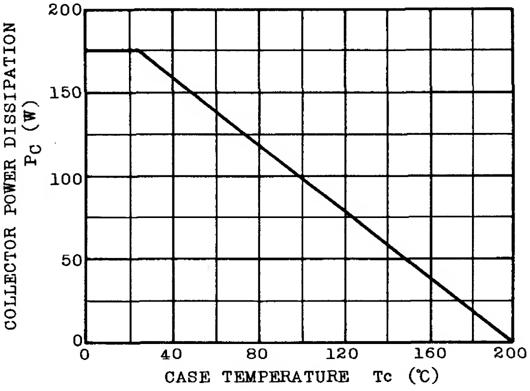
$V_{CE(sat)}$ – I_C



$V_{BE(sat)}$ – I_C



P_C – T_c



BD

SERIES

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

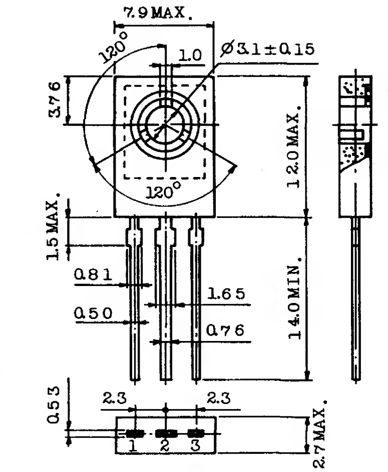
BD135
BD137
BD139

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Designed for Complementary Use with BD136, BD138 and BD140.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

Weight : 0.72g

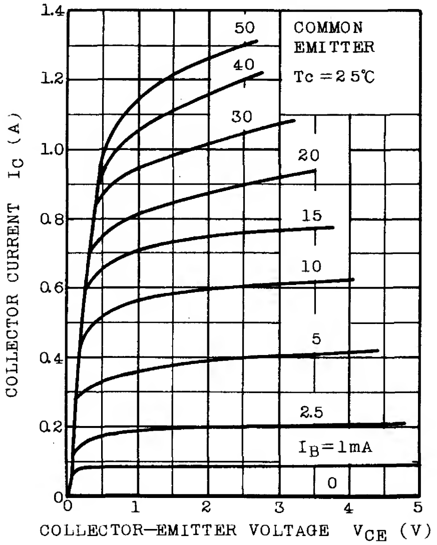
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD135	V_{CBO}	45	V
	BD137		60	
	BD139		80	
Collector-Emitter Voltage	BD135	V_{CEO}	45	V
	BD137		60	
	BD139		80	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	0.5	A
	Peak	I_{CM}	1.5	
Collector Power Dissipation	Ta=25°C	P_C	1	W
	Tc≦60°C		6.5	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

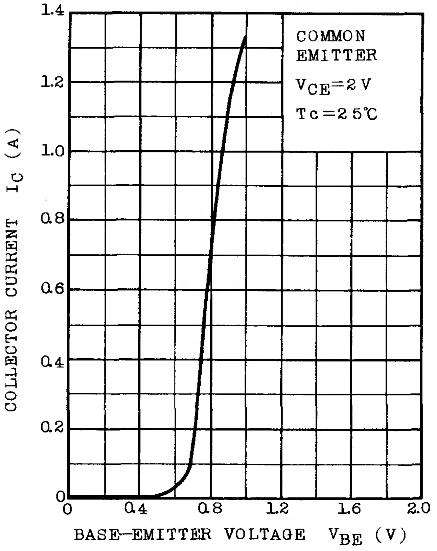
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	0.1	μA
			V_{CB}=30V, I_E=0, Ta=125°C	-	-	10	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	BD135	$V_{(BR)CEO}$	I_C=30mA, I_B=0	45	-	-	V
	BD137			60	-	-	
	BD139			80	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=5mA	25	-	-	
		$h_{FE(2)}$	V_{CE}=2V, I_C=150mA	40	-	250	
		$h_{FE(3)}$	V_{CE}=2V, I_C=500mA	25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	0.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=2V, I_C=500mA	-	-	1.0	V
Transition Frequency		f_T	V_{CE}=2V, I_C=50mA	50	250	-	MHz

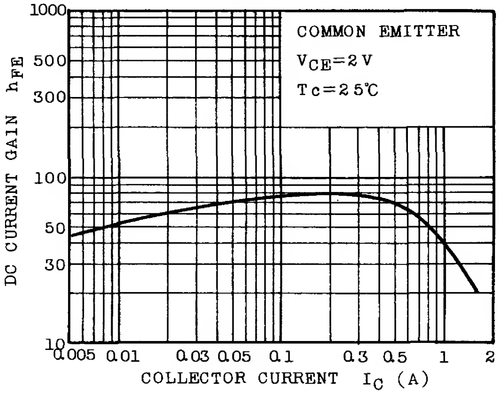
$I_C - V_{CE}$



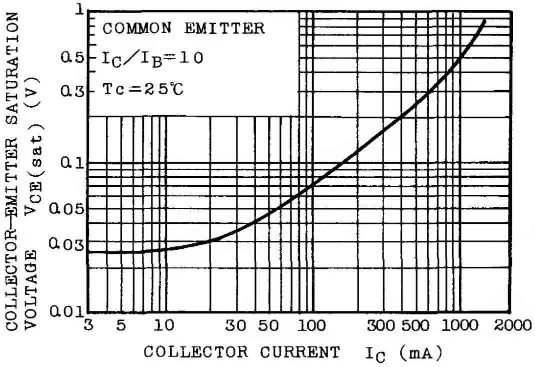
$I_C - V_{BE}$



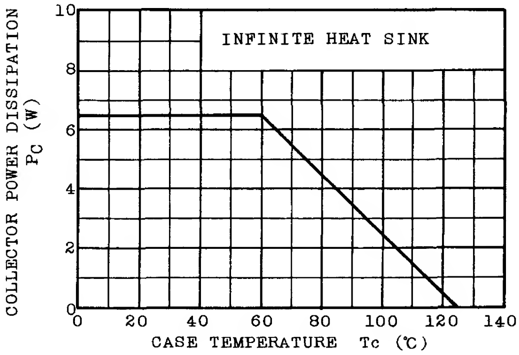
$h_{FE} - I_C$

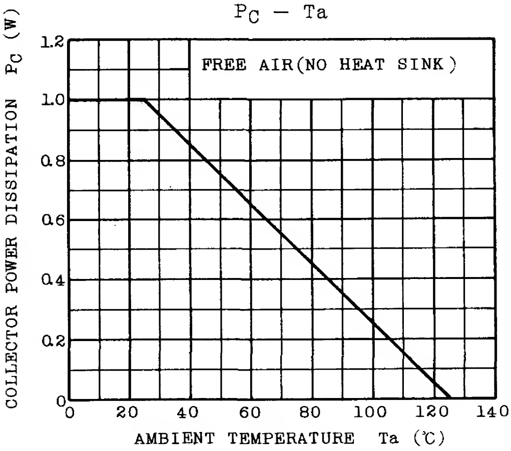


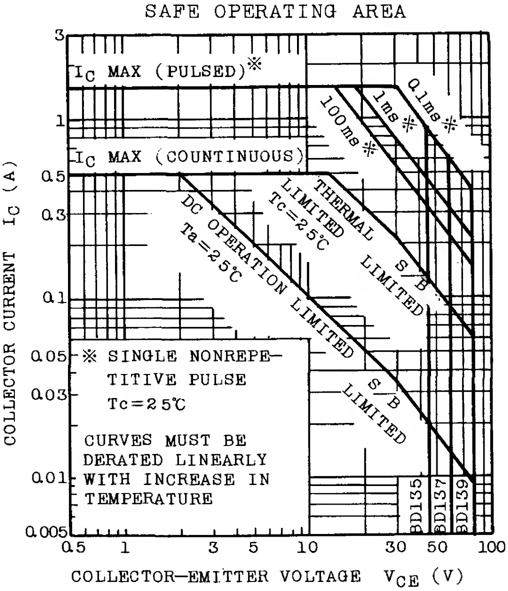
$V_{CE(sat)} - I_C$



$P_C - Tc$




P_C − Ta
FREE AIR(NO HEAT SINK)
COLLECTOR POWER DISSIPATION P_C (W)
1.2
1.0
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
AMBIENT TEMPERATURE Ta (℃)


SAFE OPERATING AREA
I_C MAX (PULSED)※
I_C MAX (COUNTINUOUS)
0.1ms※
1ms※
100ms※
THERMAL LIMITED Tc=25℃
DC OPERATION LIMITED Ta=25℃
S/B LIMITED
S/B LIMITED
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
BD135
BD137
BD139
COLLECTOR CURRENT I_C (A)
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0.005
0.5
1
3
5
10
30
50
100
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

BD136
BD138
BD140

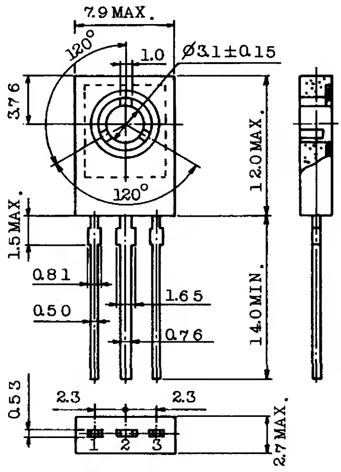
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Designed for Complementary Use with BD135, BD137 and BD139

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	—
TOSHIBA	2-8F1A

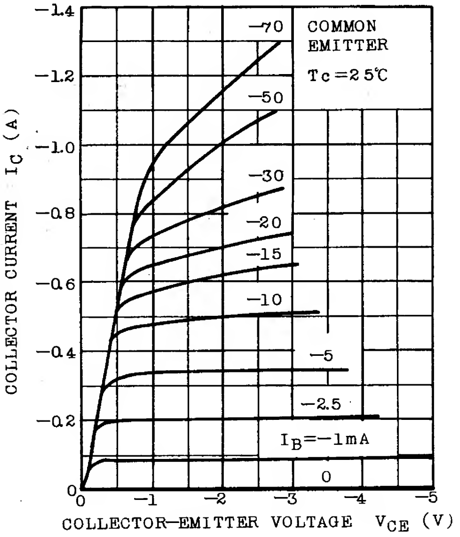
Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

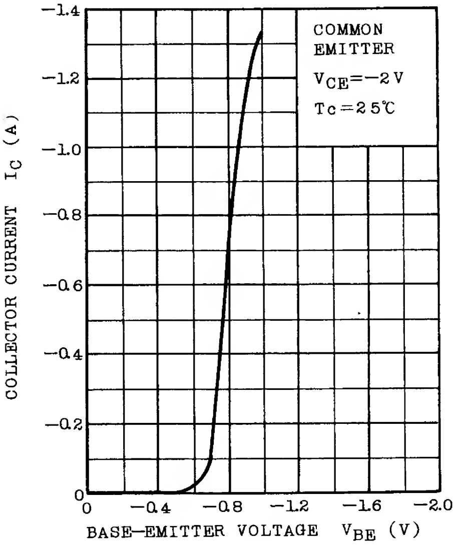
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD136	V_{CBO}	-45	V
	BD138		-60	
	BD140		-80	
Collector-Emitter Voltage	BD136	V_{CEO}	-45	V
	BD138		-60	
	BD140		-80	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current	DC	I_C	-0.5	A
	Peak	I_{CM}	-1.5	
Collector Power Dissipation	Ta=25°C	P_C	1	W
	Tc≤60°C		6.5	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

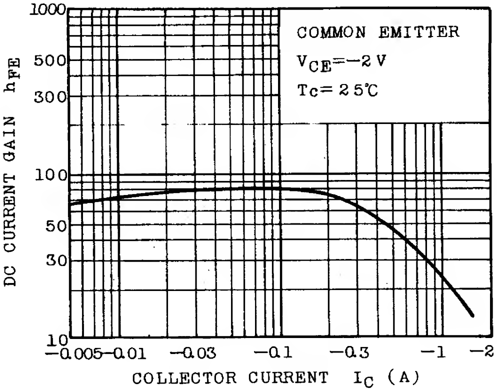
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-0.1	μA
			V_{CB}=-30V, I_E=0, Ta=125°C	-	-	-10	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	BD136	$V_{(BR)CEO}$	I_C=-30mA, I_B=0	-45	-	-	V
	BD138			-60	-	-	
	BD140			-80	-	-	
DC Current Gain		$h_{FE(1)}$	V_{CE}=-2V, I_C=-5mA	25	-	-	
		$h_{FE(2)}$	V_{CE}=-2V, I_C=-150mA	40	-	250	
		$h_{FE(3)}$	V_{CE}=-2V, I_C=-500mA	25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-0.5	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-2V, I_C=-500mA	-	-	-1.0	V
Transition Frequency		f_T	V_{CE}=-2V, I_C=-50mA	-	100	-	MHz



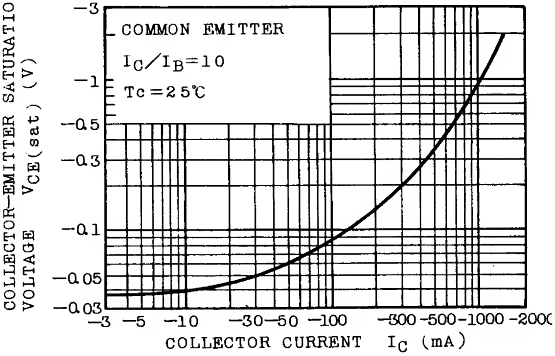
$I_C - V_{CE}$



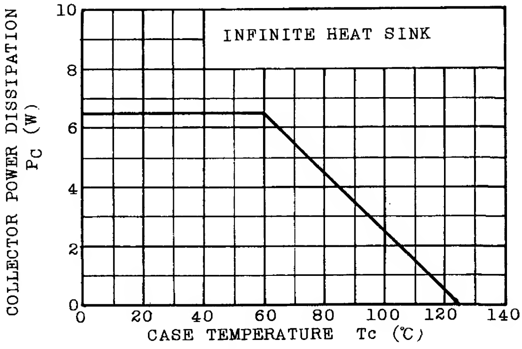
$I_C - V_{BE}$



$h_{FE} - I_C$

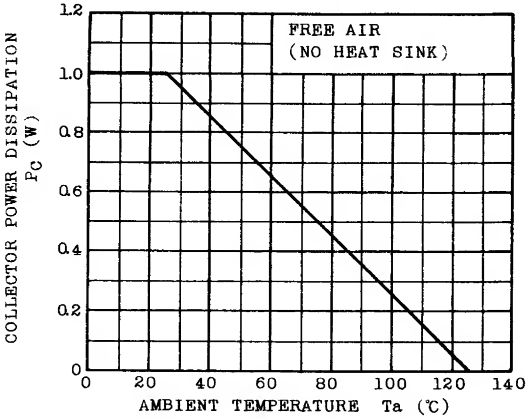


$V_{CE}(sat) - I_C$

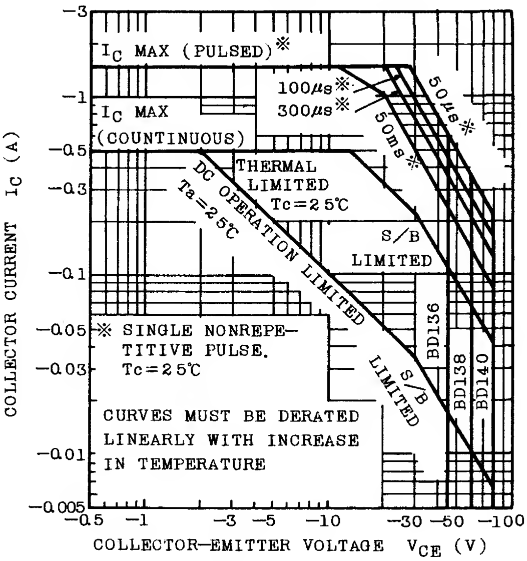


$P_C - Tc$

P_C − Ta



SAFE OPERATING AREA

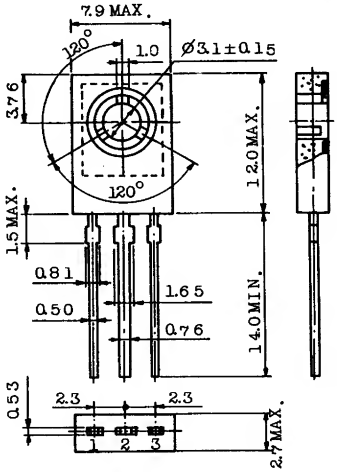


SILICON NPN EPITAXIAL BASE MESA TYPE

BD233
BD235
BD237

AUDIO POWER AMPLIFIER APPLICATIONS.
VERTICAL DEFLECTION OUTPUT APPLICATION IN TV.

Unit in mm



1. EMITTER
2. COLLECTOR(HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Weight : 0.72g

FEATURES:

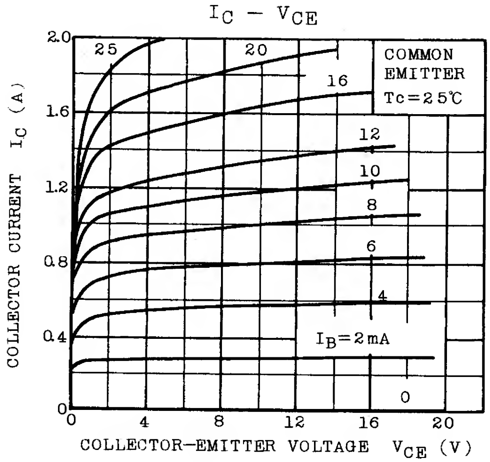
- Designed for Complementary Use with BD234, BD236 and BD238

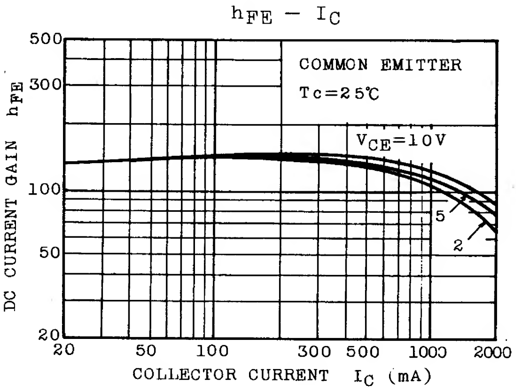
MAXIMUM RATINGS (Ta=25°C)

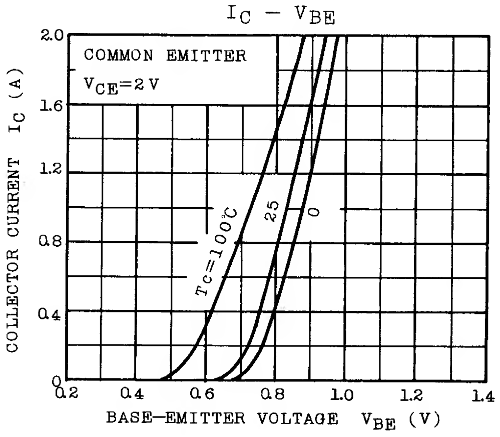
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD233	V_{CBO}	45	V
	BD235		60	
	BD237		100	
Collector-Emitter Voltage	BD233	V_{CEO}	45	V
	BD235		60	
	BD237		80	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	2	A
	Peak	I_{CM}	6	
Base Current		I_B	2	A
Collector Power Dissipation (Tc=25°C)		P_C	25	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

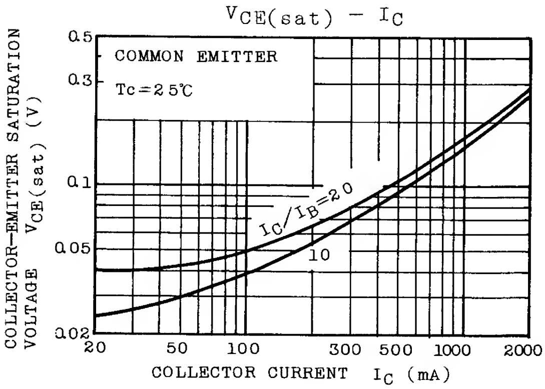
ELECTRICAL CHARACTERISTICS (Ta=25°C)

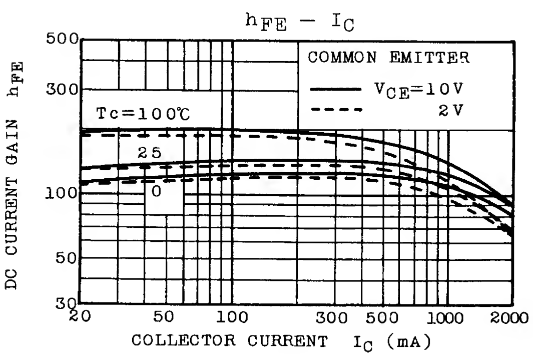
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BD233	I_{CBO}	V_{CB}=45V, I_E=0	−	−	100	μA
	BD235		V_{CB}=60V, I_E=0				
	BD237		V_{CB}=100V, I_E=0				
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	−	−	1	mA
DC Current Gain		$h_{FE(1)}$	V_{CE}=2V, I_C=150mA	40	−	−	
		$h_{FE(2)}$	V_{CE}=2V, I_C=1A	25	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=1A, I_B=0.1A	−	−	0.6	V
Base-Emitter Voltage		V_{BE}	V_{CE}=2V, I_C=1A	−	−	1.3	V
Transition Frequency		f_T	V_{CE}=10V, I_C=250mA	3	40	−	MHz

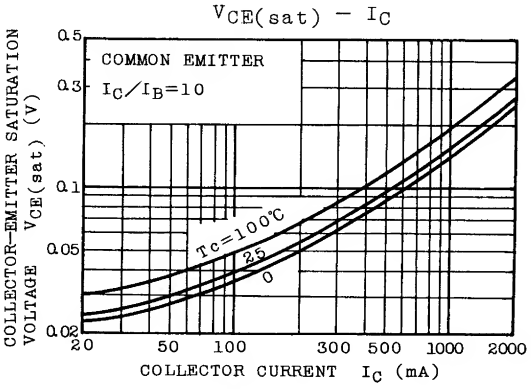

I_C — V_CE
COMMON
EMITTER
Tc=25℃
25
20
16
12
10
8
6
4
I_B=2mA
0
2.0
1.6
1.2
0.8
0.4
0
COLLECTOR CURRENT I_C (A)
0
4
8
12
16
20
COLLECTOR—EMITTER VOLTAGE V_CE (V)

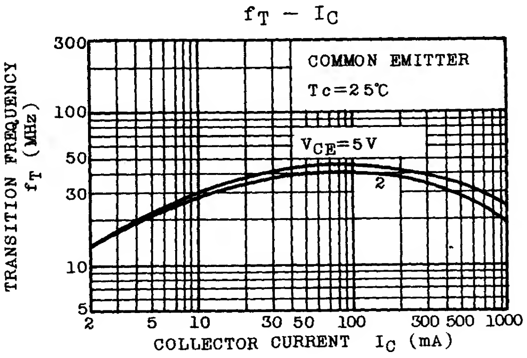

h_FE — I_C
COMMON EMITTER
Tc=25℃
V_CE=10V
5
2
500
300
100
50
20
DC CURRENT GAIN h_FE
20
50
100
300
500
1000
2000
COLLECTOR CURRENT I_C (mA)

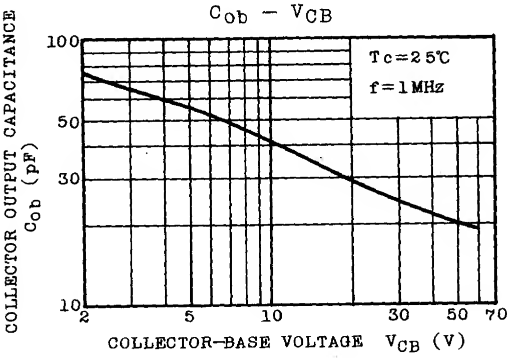

I_C — V_BE
COMMON EMITTER
V_CE=2V
Tc=100℃
25
0
2.0
1.6
1.2
0.8
0.4
0
COLLECTOR CURRENT I_C (A)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
BASE—EMITTER VOLTAGE V_BE (V)

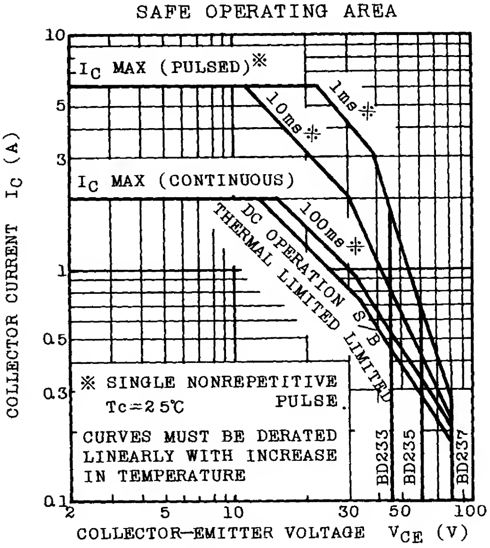

V_CE(sat) — I_C
COMMON EMITTER
Tc=25℃
I_C/I_B=20
10
0.5
0.3
0.1
0.05
0.02
COLLECTOR—EMITTER SATURATION VOLTAGE V_CE(sat) (V)
20
50
100
300
500
1000
2000
COLLECTOR CURRENT I_C (mA)


h_FE — I_C
COMMON EMITTER
V_CE=10V
2V
Tc=100℃
25
0
500
300
100
50
30
DC CURRENT GAIN h_FE
20
50
100
300
500
1000
2000
COLLECTOR CURRENT I_C (mA)


V_CE(sat) — I_C
COMMON EMITTER
I_C/I_B=10
Tc=100℃
25
0
0.5
0.3
0.1
0.05
0.02
COLLECTOR—EMITTER SATURATION VOLTAGE V_CE(sat) (V)
20
50
100
300
500
1000
2000
COLLECTOR CURRENT I_C (mA)


$f_T - I_C$


$C_{ob} - V_{CB}$


SAFE OPERATING AREA

※ SINGLE NONREPETITIVE PULSE.
Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE

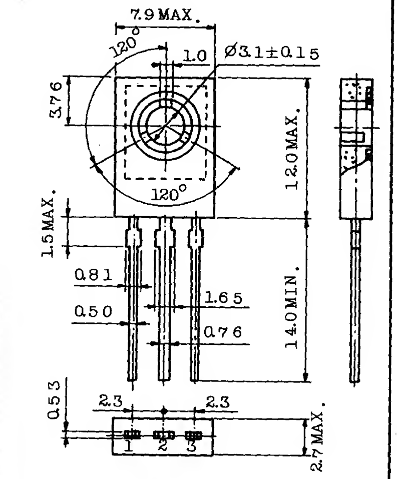
BD234
BD236
BD238

SILICON PNP EPITAXIAL BASE MESA TYPE

AUDIO POWER AMPLIFIER APPLICATIONS.

VERTICAL DEFLECTION OUTPUT APPLICATIONS IN TV.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-126
EIAJ	―
TOSHIBA	2-8F1A

Weight : 0.72g

FEATURES:

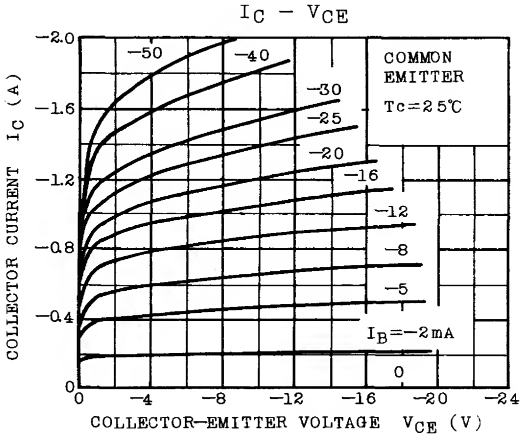
- Designed for Complementary Use with BD233, BD235 and BD237

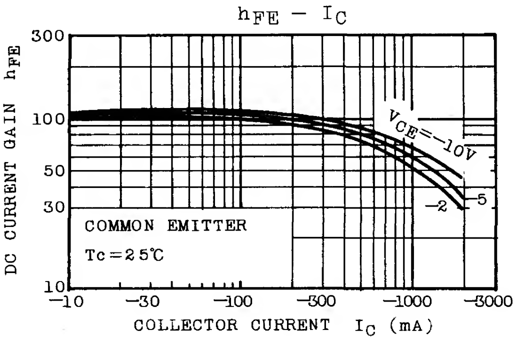
MAXIMUM RATINGS ($Ta=25^{\circ}C$)

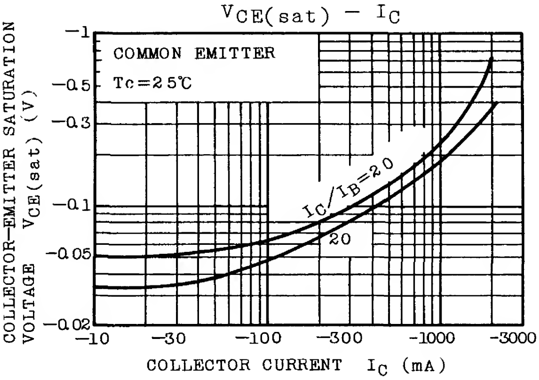
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD234	V_{CBO}	-45	V
	BD236		-60	
	BD238		-100	
Collector-Emitter Voltage	BD234	V_{CEO}	-45	V
	BD236		-60	
	BD238		-80	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current	DC	I_C	-2	A
	Peak	I_{CM}	-6	
Base Current		I_B	-2	A
Collector Power Dissipation ($Tc=25^{\circ}C$)		P_C	25	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

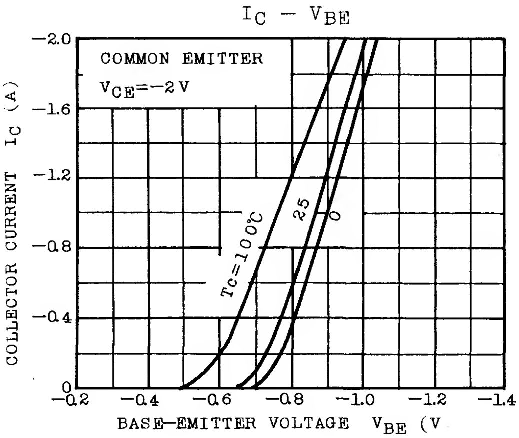
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$)

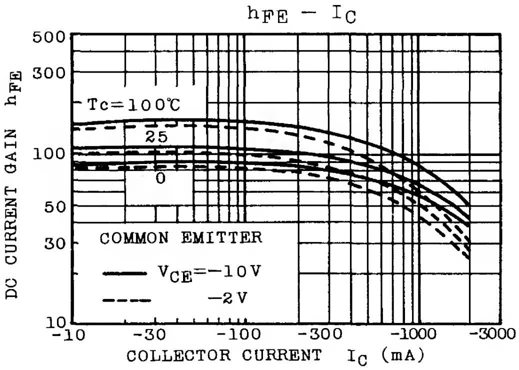
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BD234	I_{CBO}	$V_{CB}=-45V,\ I_E=0$	-	-	-100	μA
	BD236		$V_{CB}=-60V,\ I_E=0$				
	BD238		$V_{CB}=-100V,\ I_E=0$				
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V,\ I_C=0$	-	-	-1	mA
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-2V,\ I_C=-150mA$	40	-	-	
		$h_{FE(2)}$	$V_{CE}=-2V,\ I_C=-1A$	25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-1A,\ I_B=-0.1A$	-	-	-0.6	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=-2V,\ I_C=-1A$	-	-	-1.3	V
Transition Frequency		f_T	$V_{CE}=-10V,\ I_C=-250mA$	3	35	-	MHz

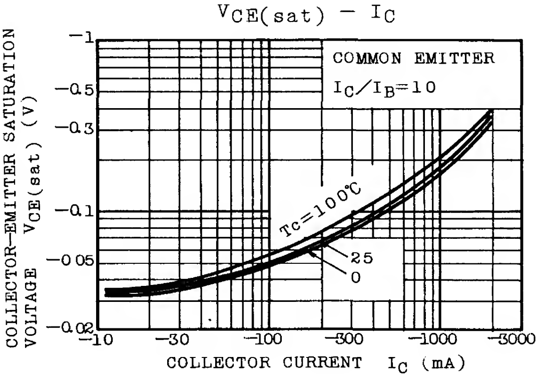

$I_C - V_{CE}$
COMMON EMITTER
Tc=25℃
−50
−40
−30
−25
−20
−16
−12
−8
−5
I_B=−2mA
0
−2.0
−1.6
−1.2
−0.8
−0.4
0
COLLECTOR CURRENT I_C (A)
0
−4
−8
−12
−16
−20
−24
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

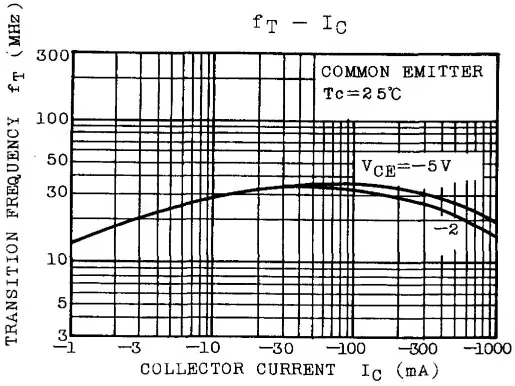

$h_{FE} - I_C$
V_{CE}=−10V
−5
−2
COMMON EMITTER
Tc=25℃
300
100
50
30
10
DC CURRENT GAIN h_{FE}
−10
−30
−100
−300
−1000
−3000
COLLECTOR CURRENT I_C (mA)

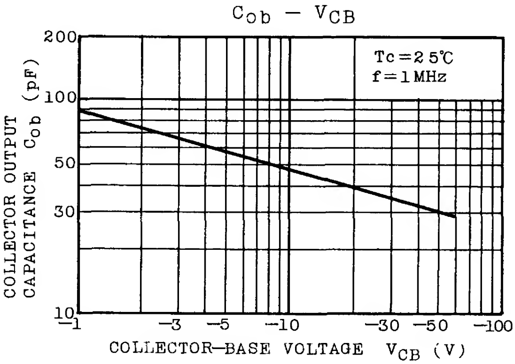

$V_{CE(sat)} - I_C$
COMMON EMITTER
Tc=25℃
I_C/I_B=20
20
−1
−0.5
−0.3
−0.1
−0.05
−0.02
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−10
−30
−100
−300
−1000
−3000
COLLECTOR CURRENT I_C (mA)

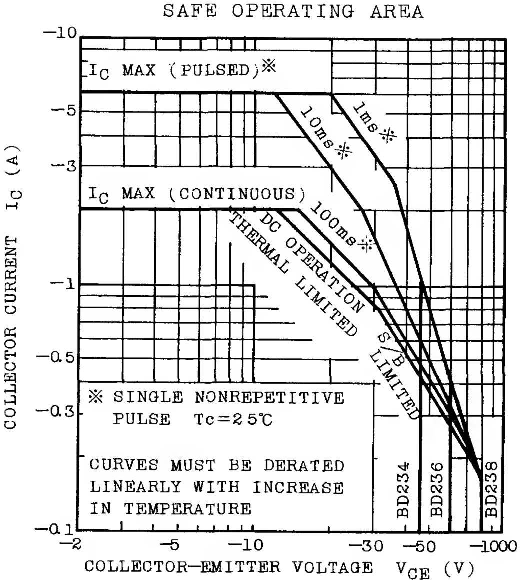

$I_C - V_{BE}$
COMMON EMITTER
V_{CE}=−2V
Tc=100℃
25
0
−2.0
−1.6
−1.2
−0.8
−0.4
0
COLLECTOR CURRENT I_C (A)
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
BASE–EMITTER VOLTAGE V_{BE} (V


$h_{FE} - I_C$
Tc=100℃
25
0
COMMON EMITTER
V_{CE}=−10V
−2V
500
300
100
50
30
10
DC CURRENT GAIN h_{FE}
−10
−30
−100
−300
−1000
−3000
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=10
Tc=100℃
25
0
−1
−0.5
−0.3
−0.1
−0.05
−0.02
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−10
−30
−100
−300
−1000
−3000
COLLECTOR CURRENT I_C (mA)


f_T – I_C
COMMON EMITTER
Tc=25℃
V_{CE}=–5V
–2
TRANSITION FREQUENCY f_T (MHz)
300
100
50
30
10
5
3
–1
–3
–10
–30
–100
–300
–1000
COLLECTOR CURRENT I_C (mA)


C_{ob} – V_{CB}
Tc=25℃
f=1MHz
COLLECTOR OUTPUT CAPACITANCE C_{ob} (pF)
200
100
50
30
10
–1
–3
–5
–10
–30
–50
–100
COLLECTOR–BASE VOLTAGE V_{CB} (V)


SAFE OPERATING AREA
I_C MAX (PULSED)※
1ms※
10ms※
I_C MAX (CONTINUOUS)
100ms※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
BD234
BD236
BD238
COLLECTOR CURRENT I_C (A)
–10
–5
–3
–1
–0.5
–0.3
–0.1
–2
–5
–10
–30
–50
–1000
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

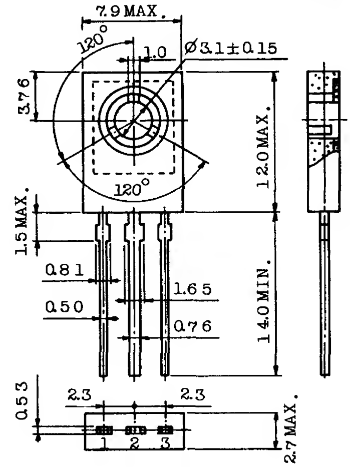
BF
SERIES

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

BF457
BF458
BF459

COLOR TV VIDEO AND CHROMA OUTPUT APPLICATIONS.
COLOR TV HORIZONTAL DRIVER APPLICATIONS.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Weight : 0.72g

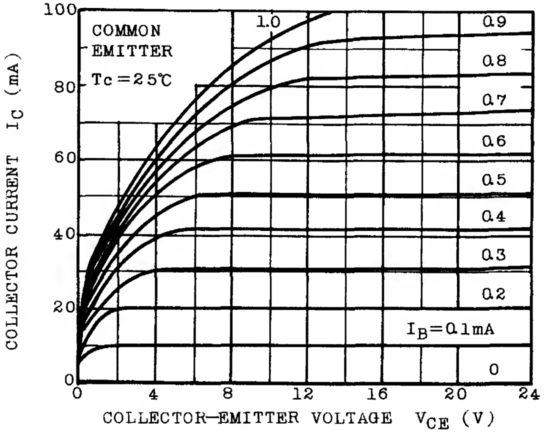
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BF457	V_{CBO}	160	V
	BF458		250	
	BF459		300	
Collector-Emitter Voltage	BF457	V_{CEO}	160	V
	BF458		250	
	BF459		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	100	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	P_C	1.2	W
	T_c=25°C		8.3	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

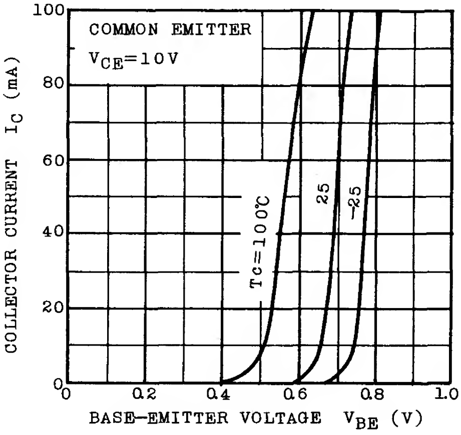
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF457	I_{CBO}	V_{CB}=100V, I_E=0	-	-	50	nA
	BF458		V_{CB}=200V, I_E=0				
	BF459		V_{CB}=250V, I_E=0				
Collector-Base Breakdown Voltage	BF457	$V_{(BR)CBO}$	I_C=100μA, I_E=0	160	-	-	V
	BF458			250	-	-	
	BF459			300	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=100μA, I_C=0	5	-	-	V
Collector-Emitter Breakdown Voltage	BF457	$V_{(BR)CEO}$	I_C=10mA, I_E=0	160	-	-	V
	BF458			250	-	-	
	BF459			300	-	-	
DC Current Gain		h_{FE}	V_{CE}=10V, I_C=30mA	25	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=30mA, I_B=6mA	-	-	1	V
Transition Frequency		f_T	V_{CE}=10V, I_C=15mA	-	100	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=30V, I_E=0, f=1MHz	-	4	-	pF

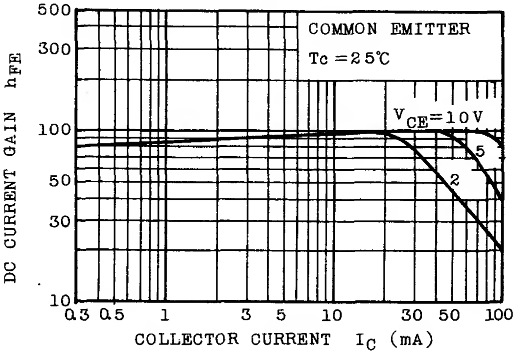
$I_C - V_{CE}$



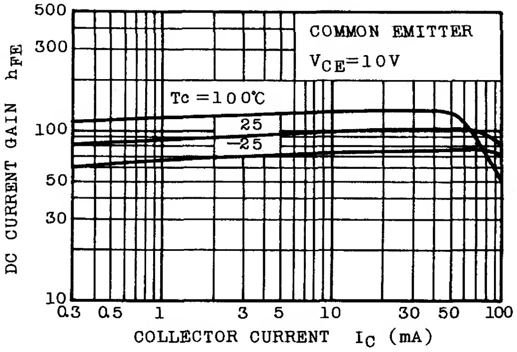
$I_C - V_{BE}$



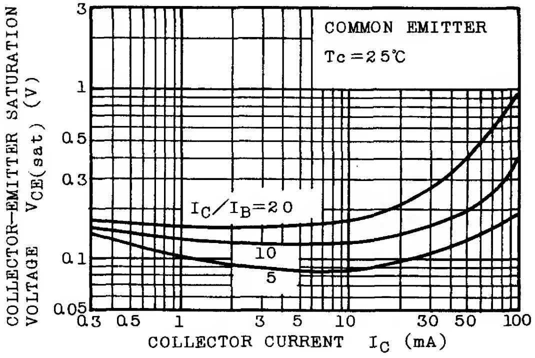
$h_{FE} - I_C$



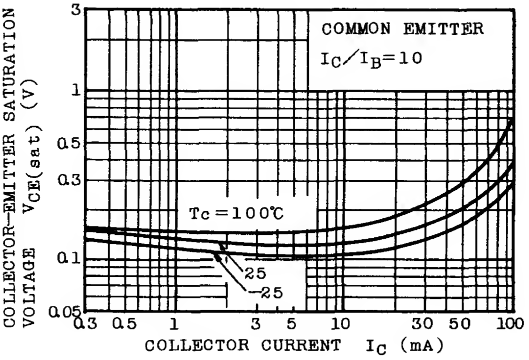
$h_{FE} - I_C$



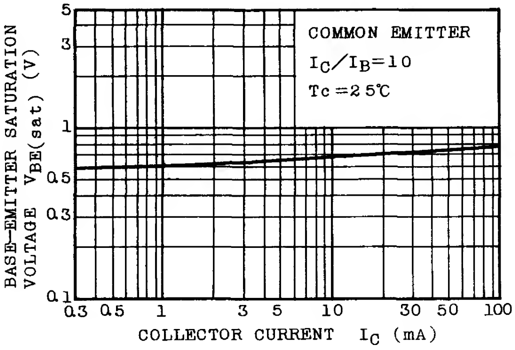
$V_{CE(sat)} - I_C$



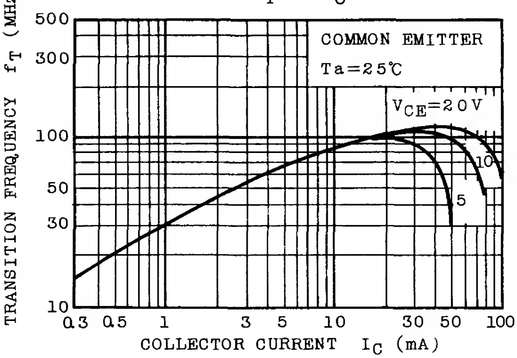
$V_{CE(sat)} - I_C$



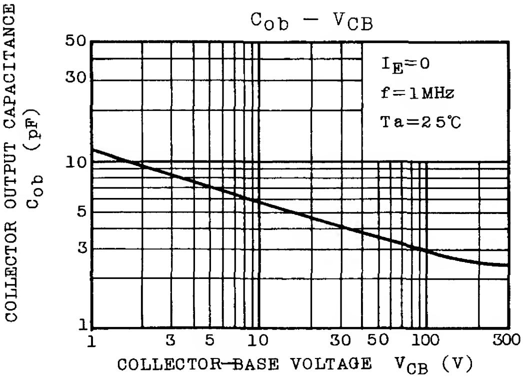
$V_{BE(sat)}$ — I_C



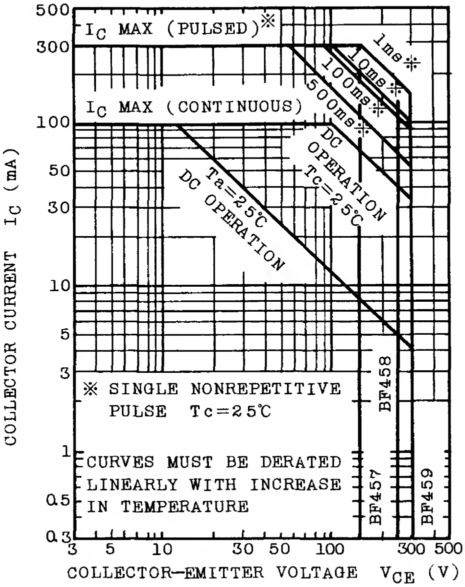
f_T — I_C



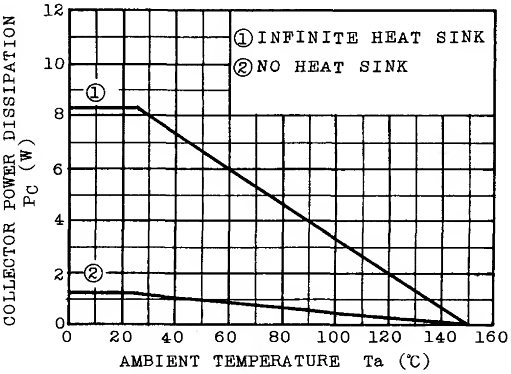
C_{ob} — V_{CB}



SAFE OPERATING AREA



P_C — Ta



BF469
BF471

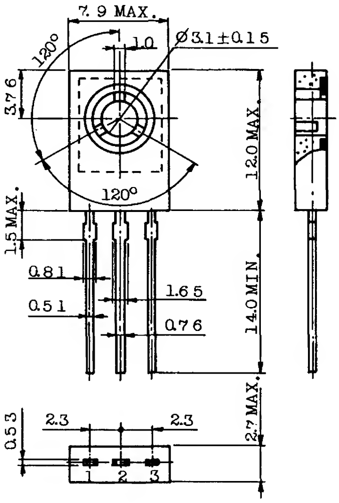
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

. PNP Complements are BF470, and BF472

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Weight : 0.72g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BF469	V_{CBO}	250	V
	BF471		300	
Collector-Emitter Voltage	BF469	V_{CEO}	250	V
	BF471		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	50	mA
	Peak	I_{CP}	100	
Total Power Dissipation	Ta=25°C	P_{tot}	1.2	W
	Tc=25°C		5.0	
Base Current		I_B	20	mA
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65~150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds.		-	350	°C

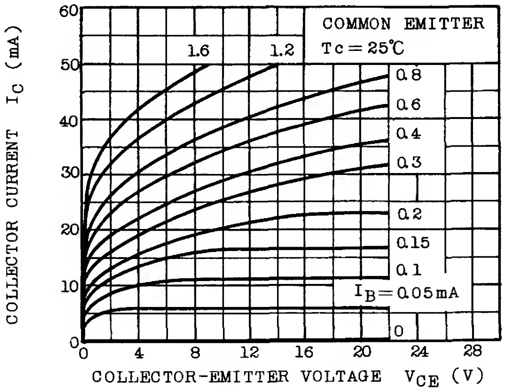
THERMAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction to Ambient)	$R\theta_{JA}$	104	°C/W
Thermal Resistance (Junction to Case)	$R\theta_{JC}$	25	°C/W

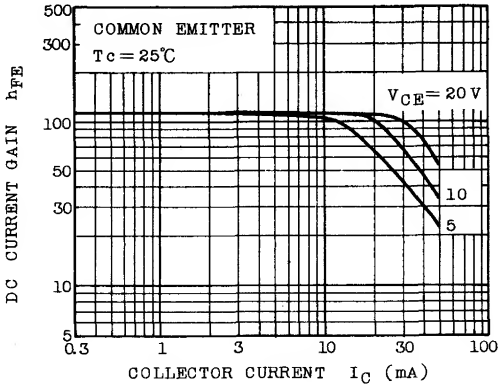
ELECTRICAL CHARACTERISTICS (Ta=25°C Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF469	I_{CBO}	V_{CB}=200V, I_E=0	-	-	0.1	μA
	BF471	I_{CER}	V_{CE}=250V, R_{BE}=2.7kΩ	-	-	0.05	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	BF469	$V_{(BR)CEO}$	I_C=1mA, I_B=0	250	-	-	V
	BF471	$V_{(BR)CER}$	I_C=1μA, R_{BE}=2.7kΩ	300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	V_{CE}=200V, R_{BE}=2.7kΩ T_j=150°C	-	-	10	μA
DC Current Gain		h_{FE}	V_{CE}=20V, I_C=25mA	50	-	-	
Collector-Emitter RF Saturation Voltage		$V_{CE(sat)}$ RF	I_C=25mA, T_j=150°C	-	20	-	V
Base-Emitter Voltage		V_{BE}	V_{CE}=20V, I_C=25mA	-	0.75	-	V
Transition Frequency		f_T	V_{CE}=10V, I_C=10mA	60	100	-	MHz
Reverse Transfer Capacitance		C_{re}	V_{CB}=30V, I_E=0, f=1MHz	-	-	1.8	pF

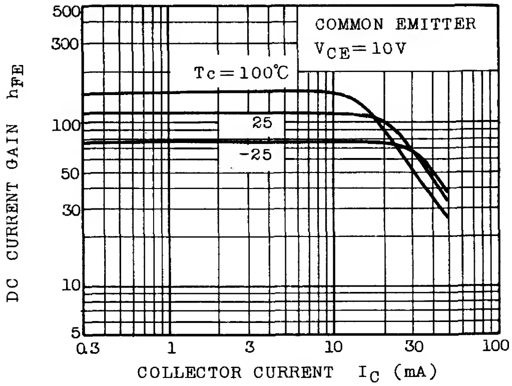
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



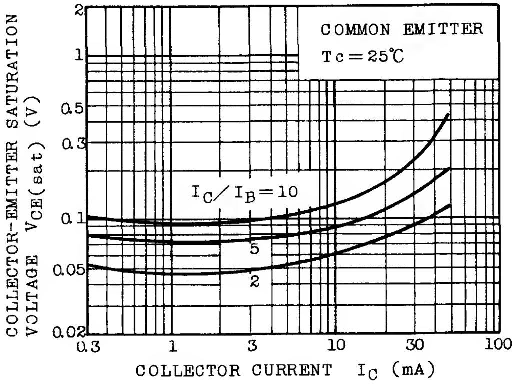
$h_{FE} - I_C$



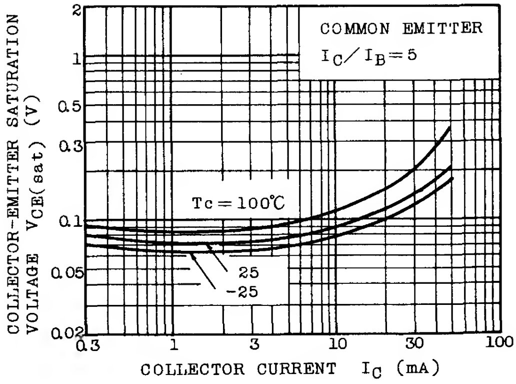
$h_{FE} - I_C$



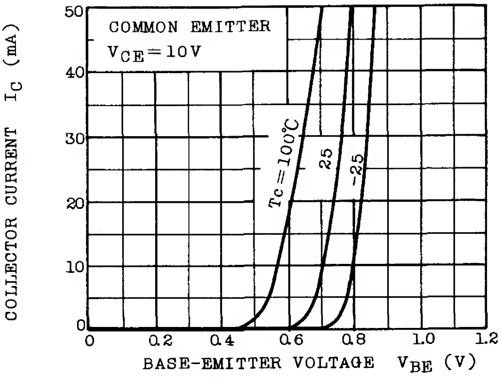
$V_{CE(sat)} - I_C$



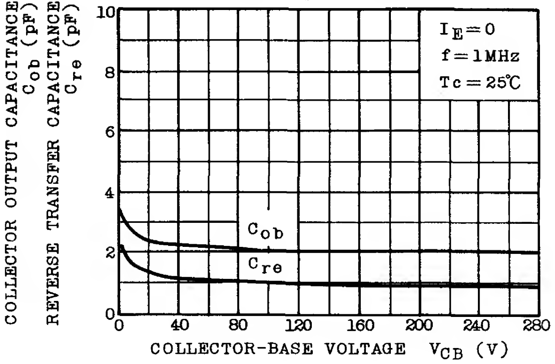
$V_{CE(sat)} - I_C$



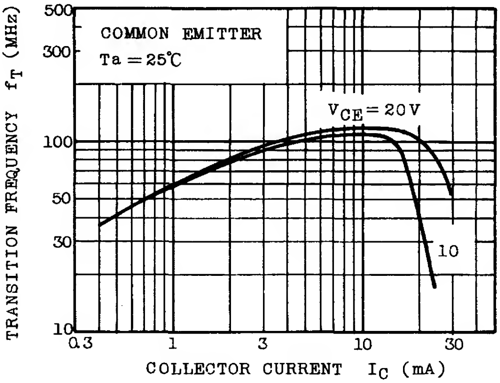
$I_C - V_{BE}$



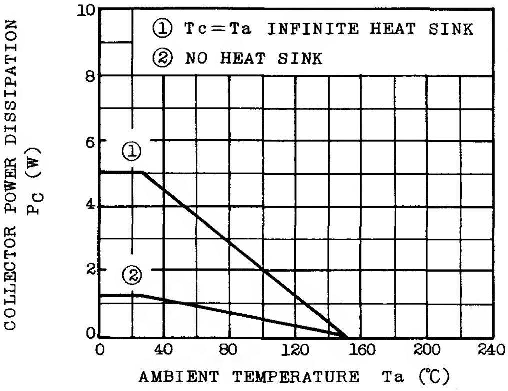
$C_{ob} \cdot C_{re} - V_{CB}$



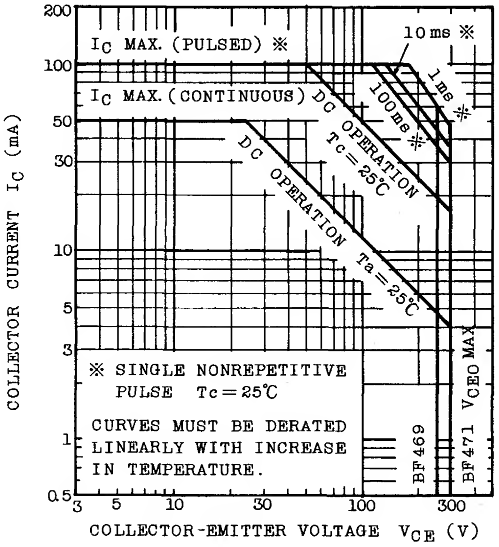
$f_T - I_C$



$P_C - Ta$



SAFE OPERATING AREA



BF470
BF472

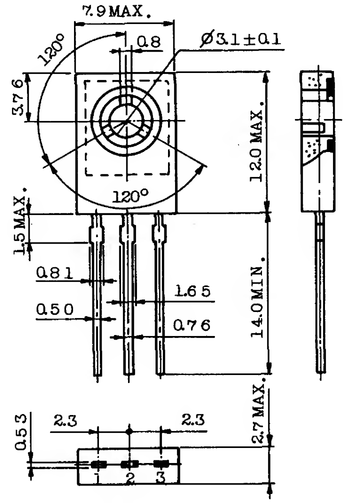
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- NPN Complements are BF469, and BF471

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO−126
EIAJ	−
TOSHIBA	2−8F1A

Weight : 0.72g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BF470	V_{CBO}	-250	V
	BF472		-300	
Collector-Emitter Voltage	BF470	V_{CEO}	-250	V
	BF472		-300	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current	DC	I_C	-50	mA
	Peak	I_{CP}	-100	
Total Power Dissipation	Ta=25°C	P_{tot}	1.2	W
	Tc=25°C		5	
Base Current		I_B	-20	mA
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65~150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds		-	350	°C

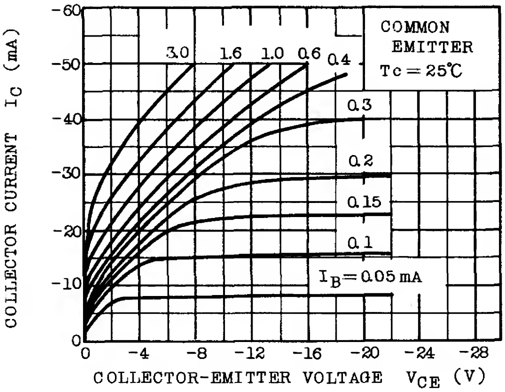
THERMAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction to Ambient)	$R\theta JA$	104	°C/W
Thermal Resistance (Junction to Case)	$R\theta_{JC}$	12.5	°C/W

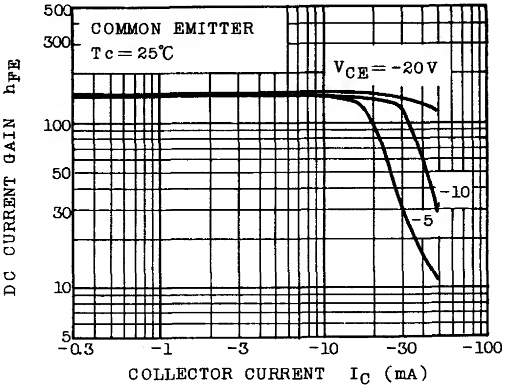
ELECTRICAL CHARACTERISTICS ($Ta=25^{\circ}C$ Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF470	I_{CBO}	V_{CB}=-200V, I_E=0	-	-	-0.1	μA
	BF472	I_{CER}	V_{CE}=-250V, R_{BE}=2.7kΩ	-	-	-0.05	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	BF470	$V_{(BR)CEO}$	I_C=-1mA, I_B=0	-250	-	-	V
	BF472	$V_{(BR)CER}$	I_C=-1μA, R_{BE}=2.7kΩ	-300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	V_{CE}=-200V, R_{BE}=2.7kΩ T_j=150°C	-	-	-10	μA
DC Current Gain		h_{FE}	V_{CE}=-20V, I_C=-25mA	50	-	-	
Collector-Emitter Saturation Voltage	RF	$V_{CE(sat)}$ RF	I_C=-25mA, T_j=150°C	-	-20	-	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-20V, I_C=-25mA	-	-0.75	-	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-10mA	60	80	-	MHz
Reverse Transfer Capacitance		C_{re}	V_{CB}=-30V, I_E=0, f=1MHz	-	-	1.8	pF

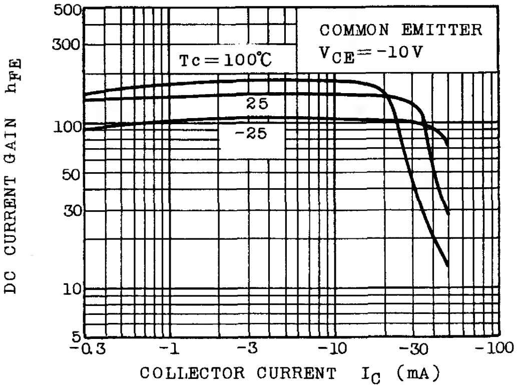
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



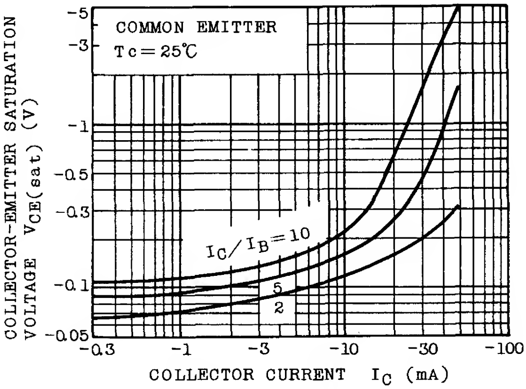
$h_{FE} - I_C$



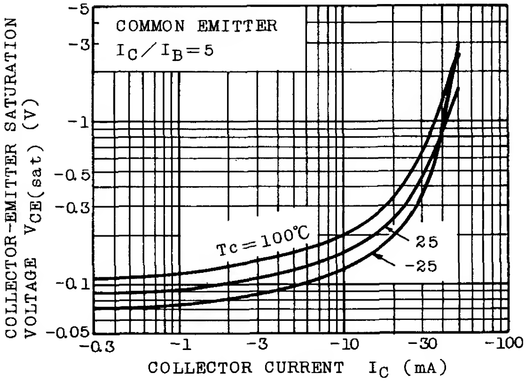
$h_{FE} - I_C$



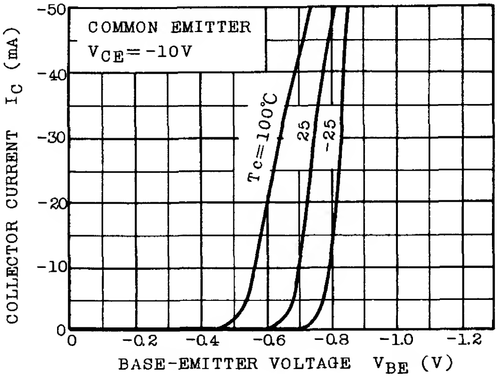
$V_{CE(sat)} - I_C$



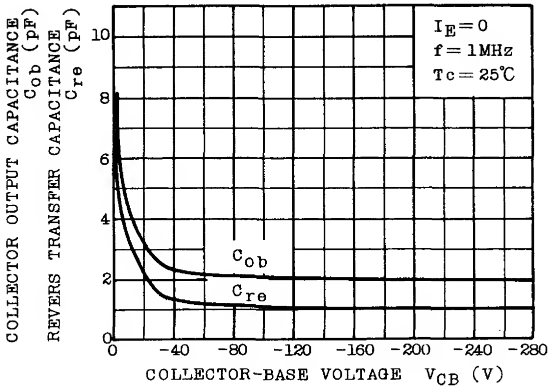
$V_{CE(sat)} - I_C$



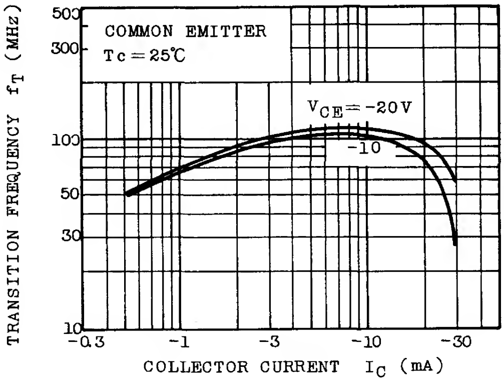
$I_C - V_{BE}$



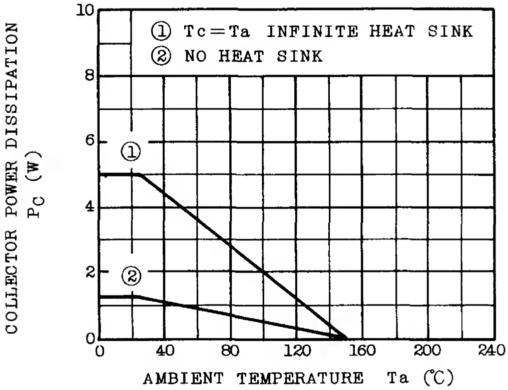
$C_{ob} \cdot C_{re} - V_{CB}$



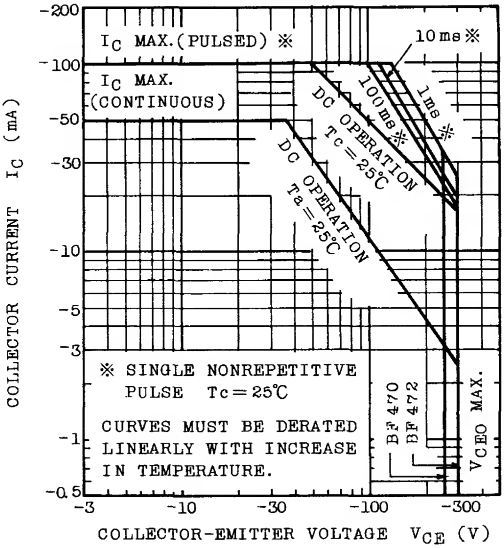
$f_T - I_C$



$P_C - Ta$



SAFE OPERATING AREA



BU

SERIES

SILICON NPN TRIPLE DIFFUSED MESA TYPE

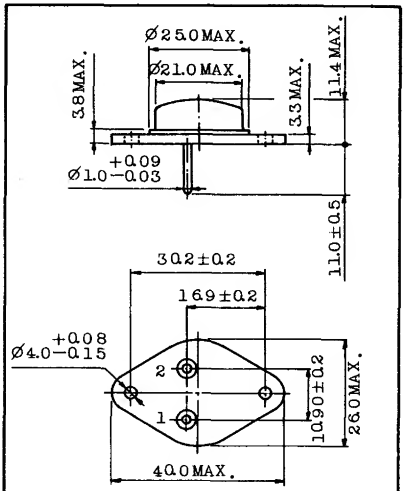
BU126

HIGH VOLTAGE NPN SILICON POWER TRANSISTOR INTENDED FOR USE IN THE SWITCHED MODE POWER SUPPLY OF TELEVISION RECEIVERS.

FEATURES:

- High Breakdown Voltage : $V_{CES}=750V$
- Low Saturation Voltage
  : $V_{CE(sat)}=5V$ (Max.) at $I_C=4A$, $I_B=1A$
- High speed : $t_f=0.15\mu s$ (Typ.)

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Mounting Kit No. AC42C

Weight : 17.0g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	750	V
		V_{CEX} ($-V_{BE}=1.5V$)	750	V
		V_{CEO}	300	V
Collector Current	DC	I_C	3	A
	Peak	I_{CM}	6	A
		$-I_{CM}$	3	A
Base Current	DC	I_B	2	A
	Peak	I_{BM}	2	A
		$-I_{B(AV)}$	100	mA
		(DC or averaged over any 20mS period)		
		$-I_{BM}$	1.5	A
		(turn-off current)		
Total Collector Power Dissipation ($T_c=25^{\circ}C$)		P_{tot}	50	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65～150	°C
Thermal Resistance		$R_{th(j-c)}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		$I_{CES}(1)$	$V_{CE}=750V$, $V_{BE}=0$	-	-	0.5	mA
		$I_{CES}(2)$	$V_{CE}=750V$, $V_{BE}=0$ $T_j=125^{\circ}C$	-	-	2	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V$, $I_C=0$	-	-	5	mA
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=1A$	15	-	60	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}(1)$	$I_C=2.5A$, $I_B=0.25A$	-	-	10	V
		$V_{CE(sat)}(2)$	$I_C=4A$, $I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=2.5A$, $I_B=0.25A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	Fig. 1	300	-	-	V
Transition Frequency		f_T	$V_{CE}=10V$, $I_C=0.2A$, f=1MHz	-	8	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	-	85	-	pF
Emitter Capacitance		C_{TE}	$V_{EB}=2V$, $I_C=0$, f=1MHz	-	1.4	-	nF
Switching Time	Fall Time	t_f	Fig. 2	-	0.15	-	μs
	Storage Time	t_{stg}		-	1.2	-	μs

SILICON NPN TRIPLE DIFFUSED MESA TYPE

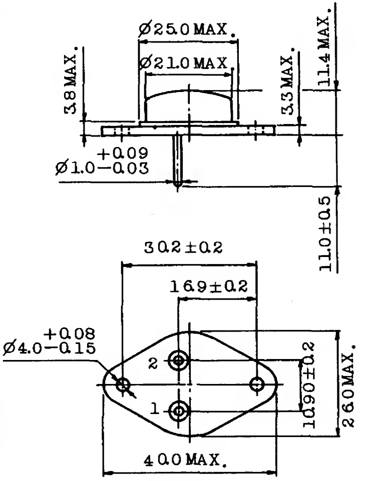
BU204
BU205

TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1300V (BU204)
  1500V (BU205)
- High Speed : t_f=0.75 μs (Typ.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Weight : 17.0g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage (V_{BE}=0V)	BU204	V_{CES}	1300	V
	BU205		1500	
Collector-Emitter Voltage (R_{BE}=100Ω)	BU204	V_{CER}	1300	V
	BU205		1500	
Transient Collector-Emitter Voltage (Flash-over)	BU204	V_{CE} (Flash-over)	1500	V
	BU205		1650	
Collector-Emitter Voltage (Open Base)	BU204	V_{CEO}	600	V
	BU205		700	
Collector Current	DC	I_C	2.5	A
	Peak	I_{CM}	3	
Transient Collector Current (Flash-over)		I_C (Flash-over)	5	A
Base Current (Peak)		I_{BM}	2.5	A
Reverse Base Current	DC	$-I_B$	100	mA
	Peak	$-I_{BM}$	1.5	A
Collector Power Dissipation (T_c≦90°C)		P_C	10	W
Junction Temperature		T_j	115	°C
Storage Temperature Range		T_{stg}	-65 ~ 115	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	$V_{BE}=0$, $V_{CE}=V_{CES}$	-	-	1	mA
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=2A$	2	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=100mA$, $I_C=0$	5	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=2A$, $I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=2A$, $I_B=1A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	BU204	$V_{CEO(SUS)}$	$I_C=100mA$, L=25mH	600	-	-	V
	BU205			700	-	-	
Fall Time		t_f	$I_{CP}=2A$, $I_{B(end)}=1A$	-	0.75	-	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, f=1MHz	-	95	-	pF
Transition Frequency		f_T	$V_{CE}=5V$, f=5MHz $I_C=0.1A$	-	3	-	MHz

SILICON NPN TRIPLE DIFFUSED MESA TYPE

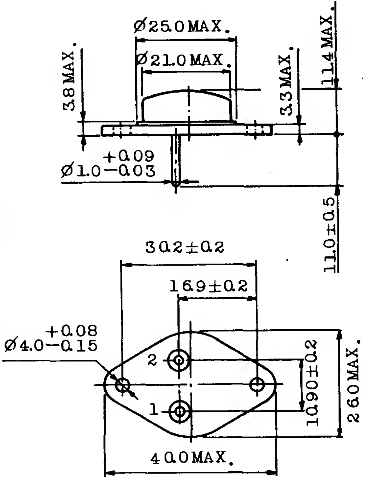
BU207

TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1300V
- High Speed : t_f=0.7μs (Typ.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Weight : 17.0g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage (V_{BE}=0V)		V_{CES}	1300	V
Collector-Emitter Voltage (R_{BE}=100Ω)		V_{CER}	1300	V
Transient Collector-Emitter Voltage (Flash-over)		V_{CE} (Flash-over)	1500	V
Collector-Emitter Voltage (Open Base)		V_{CEO}	600	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	
Transient Collector Current (Flash-over)		I_C (Flash-over)	10	A
Base Current (Peak)		I_{BM}	4	A
Reverse Base Current	DC	$-I_B$	100	mA
	Peak	$-I_{BM}$	2.5	A
Collector Power Dissipation (T_c≦95°C)		P_C	12.5	W
Junction Temperature		T_j	115	°C
Storage Temperature Range		T_{stg}	-65∼115	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	V_{CE}=1300V, V_{BE}=0V	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=100mA, I_C=0	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4.5A, I_B=2.0A	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4.5A, I_B=2.0A	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	I_C=100mA, L=25mH	600	-	-	V
Fall Time	t_f	I_C=4.5A, $I_{B(end)}$=1.8A	-	0.7	1	μs
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	165	-	pF
Transition Frequency	f_T	V_{CE}=5V, f=5MHz, I_C=0.1A	-	3	-	MHz

BU208

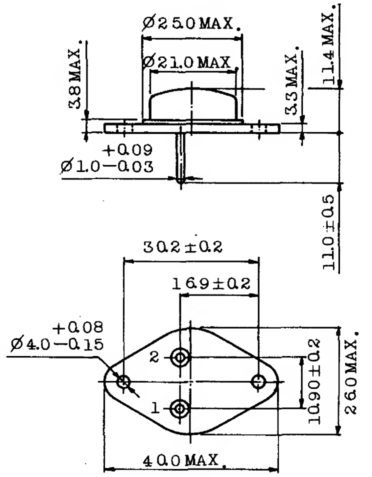
SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V (Max.)
- Fall Time : t_f=0.7µs (Typ.)
- Glass Passivated Base-Collector Junction

Unit in mm



1. BASE
2. EMITTER
   COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Mounting Kit No. AC42C

Weight : 17.0g

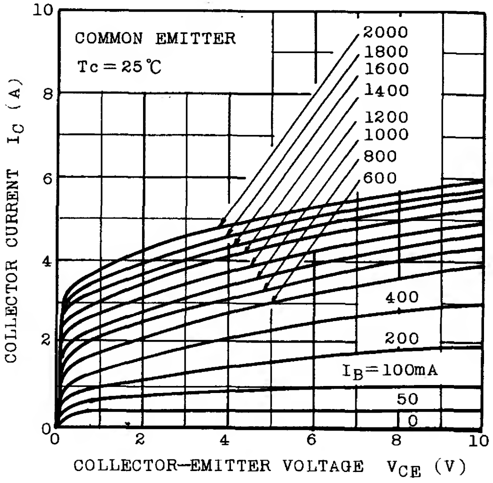
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc ≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-65 ~115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

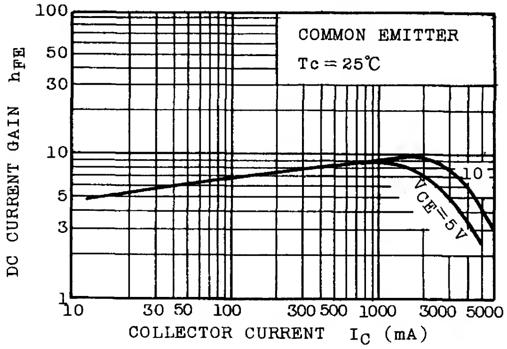
ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4.5A, I_B=2A	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	-	-	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0, L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	125	-	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	0.7	-	µs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	10	-	µs

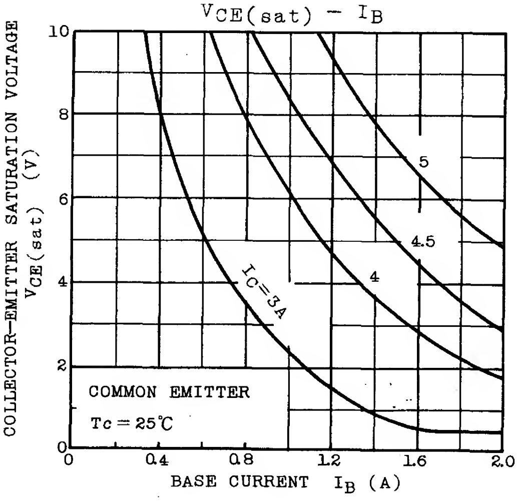
I_C — V_{CE}



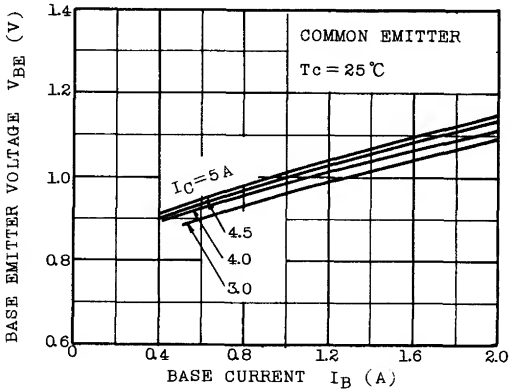
h_{FE} — I_C



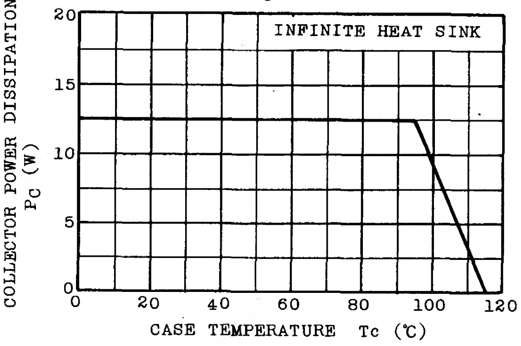
$V_{CE(sat)}$ — I_B



V_{BE} — I_B



P_C — Tc

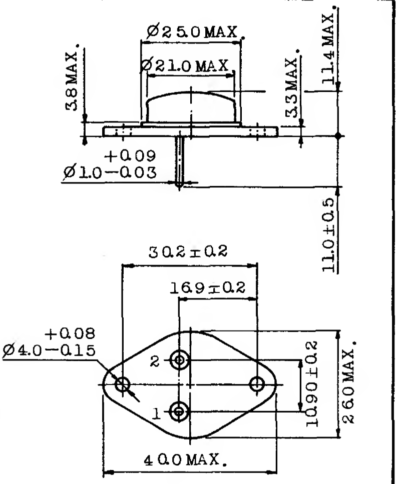


BU208A

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
COLOR TV SWITCHING REGULATOR APPLICATIONS.

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Mounting Kit No. AC42C

Weight : 17.0g

FEATURES:

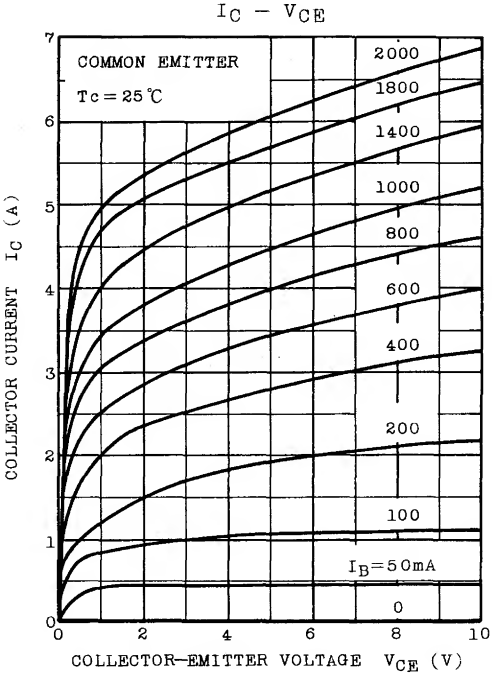
- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=1V (Max.)
- Fall Time : t_f=0.7μs (Typ.)
- Glass Passivated Collector-Base Junction

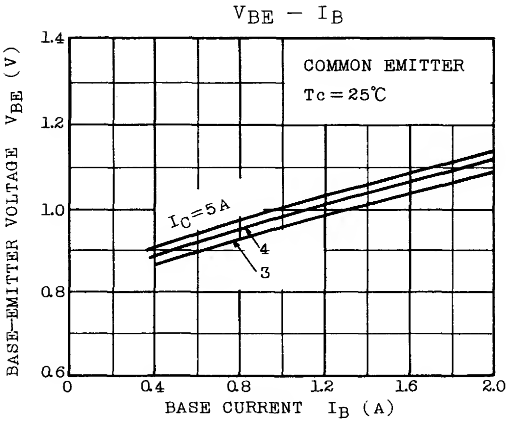
MAXIMUM RATINGS (Ta=25°C)

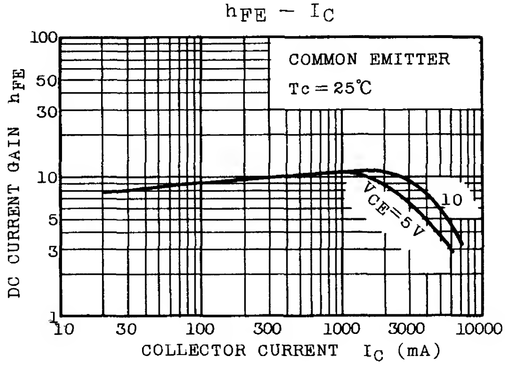
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	−65～+115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

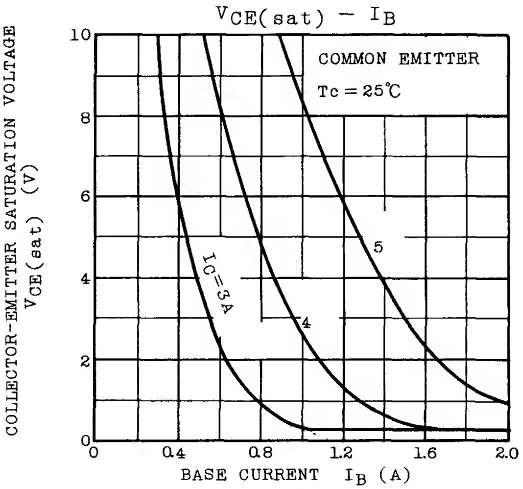
ELECTRICAL CHARACTERISTICS (Tc=25°C)

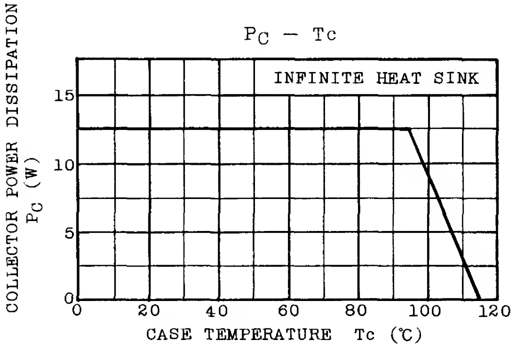
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	−	−	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	−	−	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	−	−	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4.5A, I_B=2A	−	−	1	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	−	−	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0 L=25mH	700	−	−	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	−	7	−	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	125	−	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	−	0.7	−	μs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	−	10	−	μs

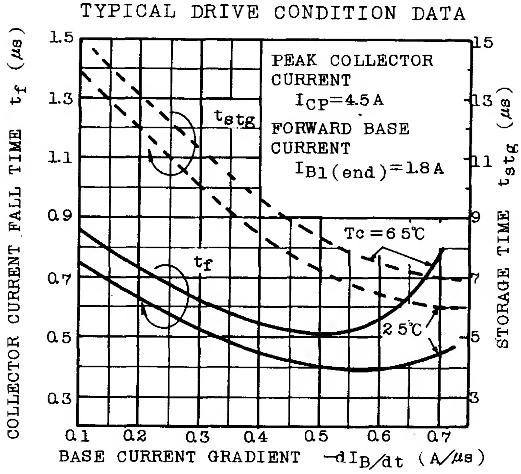

$I_C - V_{CE}$
COMMON EMITTER
Tc = 25℃
2000
1800
1400
1000
800
600
400
200
100
I_B=50mA
0
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

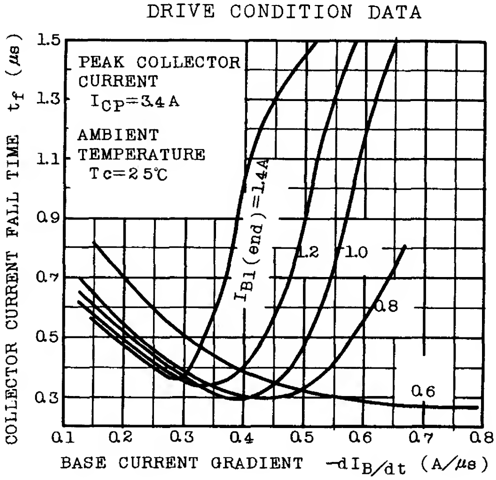

$V_{BE} - I_B$
COMMON EMITTER
Tc = 25℃
I_C=5A
4
3
BASE-EMITTER VOLTAGE V_{BE} (V)
0.6
0.8
1.0
1.2
1.4
0
0.4
0.8
1.2
1.6
2.0
BASE CURRENT I_B (A)

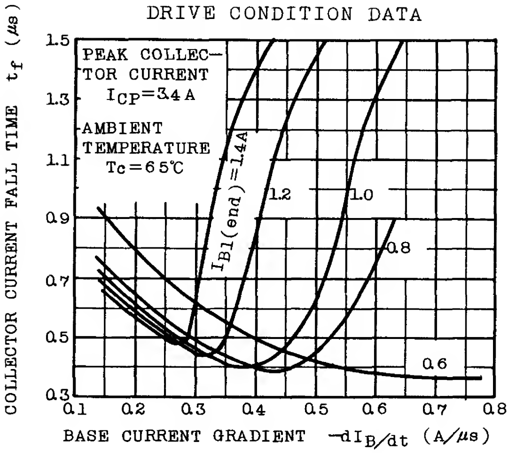

$h_{FE} - I_C$
COMMON EMITTER
Tc = 25℃
V_{CE}=5V
10
DC CURRENT GAIN h_{FE}
1
3
5
10
30
50
100
10
30
100
300
1000
3000
10000
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_B$
COMMON EMITTER
Tc = 25℃
I_C=3A
4
5
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
0
2
4
6
8
10
0
0.4
0.8
1.2
1.6
2.0
BASE CURRENT I_B (A)


$P_C - Tc$
INFINITE HEAT SINK
COLLECTOR POWER DISSIPATION P_C (W)
0
5
10
15
0
20
40
60
80
100
120
CASE TEMPERATURE Tc (℃)


TYPICAL DRIVE CONDITION DATA


DRIVE CONDITION DATA


DRIVE CONDITION DATA

SILICON NPN TRIPLE DIFFUSED MESA TYPE

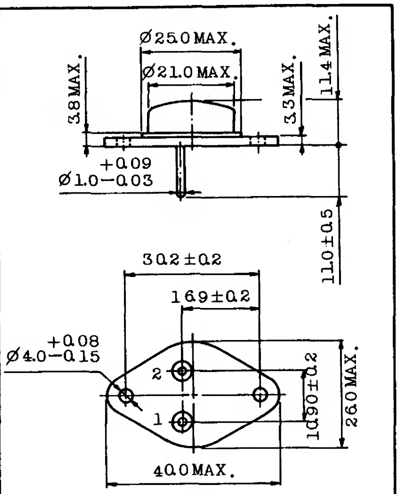
BU326A

HIGH POWER SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CBO}=900V
- High Peak Current Capability : $I_{C(Peak)}$=8A
- Fall Time : t_f=0.5μs (Max.)
- Glass Passivated Collector-Base Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Mounting Kit No. AC42C

Weight : 17.0g

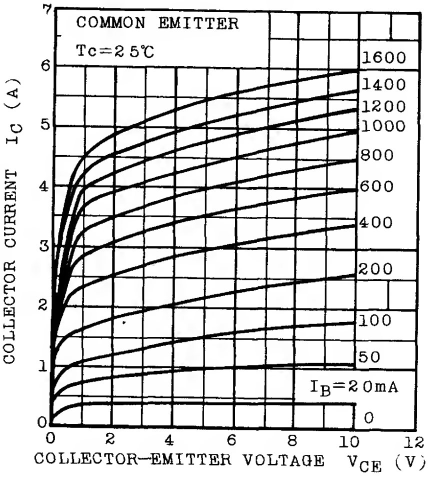
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	6	A
	Peak	I_{CP}	8	A
Collector Power Dissipation (Tc=25°C)		P_C	60	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65 ~150	°C

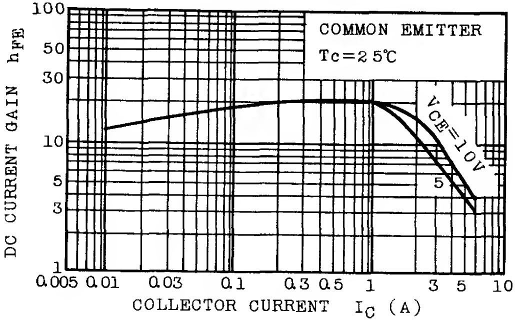
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	I_C=1mA, I_E=0	900	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	400	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=5mA, I_C=0	7	-	-	V
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=4A	3.5	-	12	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=1.25A	-	-	3	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=4A, I_B=1.25A	-	-	1.5	V
Fall Time	t_f	I_{CP}=2.5A, I_{B1}=0.5A I_{B2}=-1A	-	-	0.5	μs
Transition Frequency	f_T	V_{CE}=10V, I_C=0.1A	-	5	-	MHz

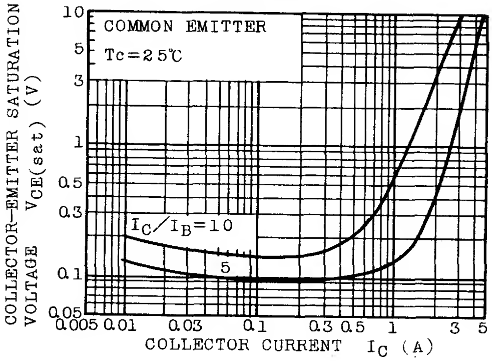
I_C – V_{CE}



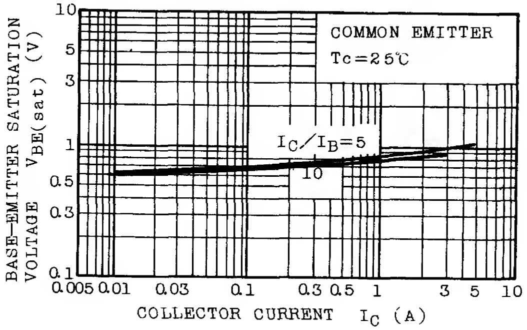
h_{FE} – I_C



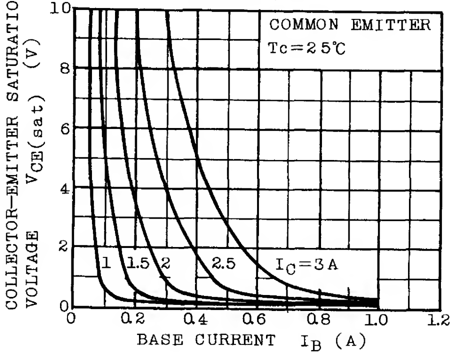
$V_{CE(sat)}$ – I_C



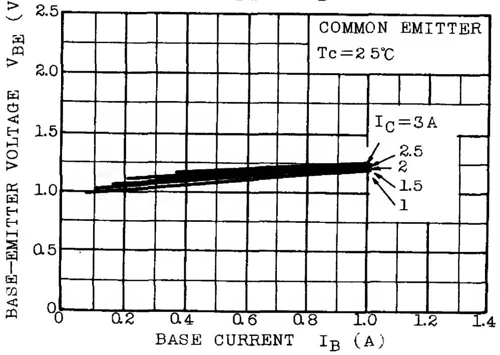
$V_{BE(sat)}$ – I_C



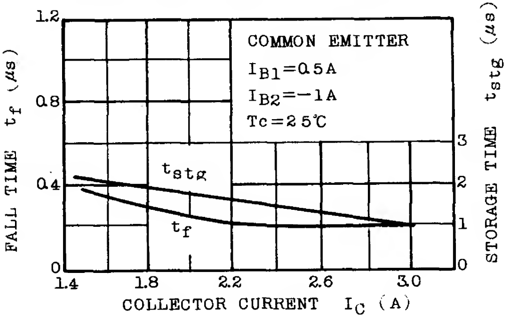
$V_{CE(sat)}$ – I_B



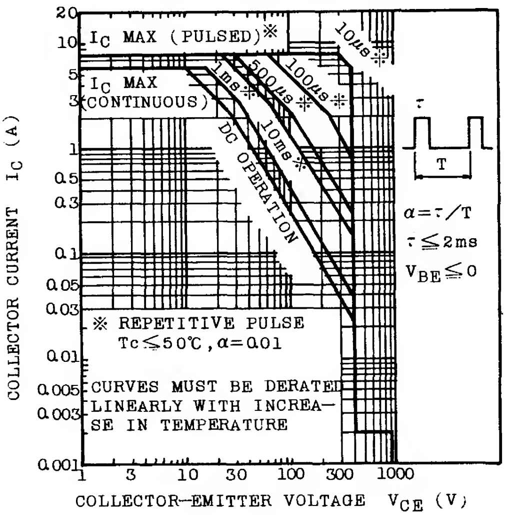
V_{BE} – I_B



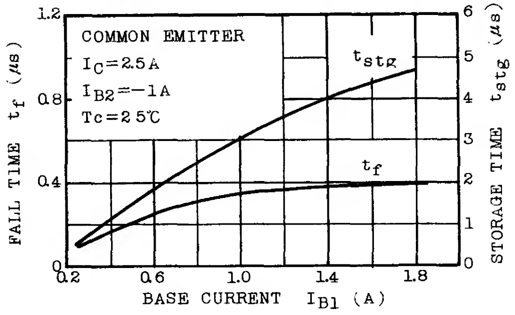
SWITCHING CHARACTERISTICS



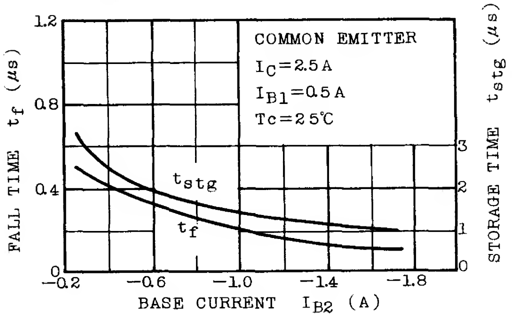
SAFE OPERATING AREA



SWITCHING CHARACTERISTICS



SWITCHING CHARACTERISTICS



BU407D

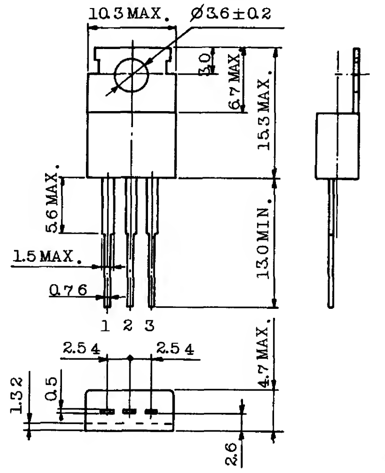
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- Built in Damper Type
- High Collector Current Capability
  High Collector Power Dissipation Capability

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

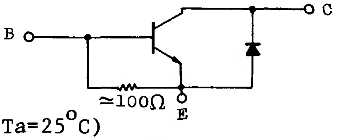
Mounting Kit No. AC75

Weight : 1.9g

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	330	V
Collector-Emitter Voltage		V_{CEO}	150	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	7	A
	Repetitive	I_{CM}	10	A
	Peak	I_{CP}	15	A
Base Current (Repetitive)		I_{BM}	2	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	60	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

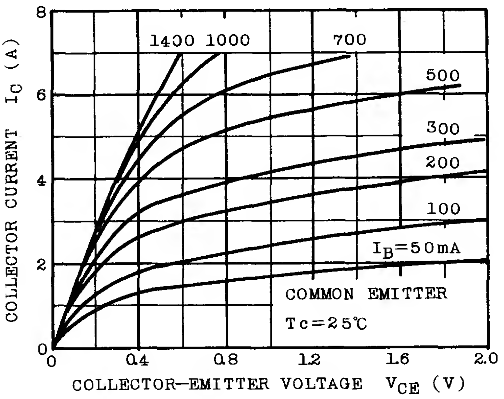
EQUIVALENT CIRCUIT



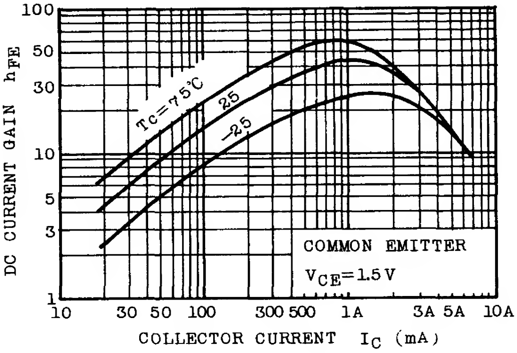
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=250V$, $V_{BE}=0$	-	-	1.0	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.1A$, $L=50mH$	150	-	-	V
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	330	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1A$, $I_C=0$	6	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=1.5V$, $I_C=5A$	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A$, $I_B=0.5A$	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A$, $I_B=0.5A$	-	-	1.5	V
Forward Voltage (Diode)	$-V_F$	$I_C=-6A$	-	-	1.8	V
Fall Time	t_f	$I_{CP}=5A$, $I_{B1}=-I_{B2}=0.5A$	-	-	1.0	μs
Transition Frequency	f_T	$V_{CE}=10V$, $I_C=0.2A$	-	18	-	MHz

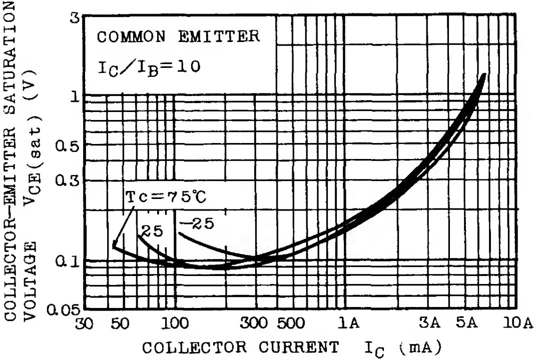
I_C — V_{CE} (LOW VOLTAGE REGION)



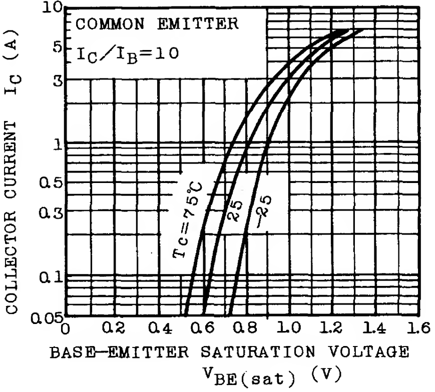
h_{FE} — I_C



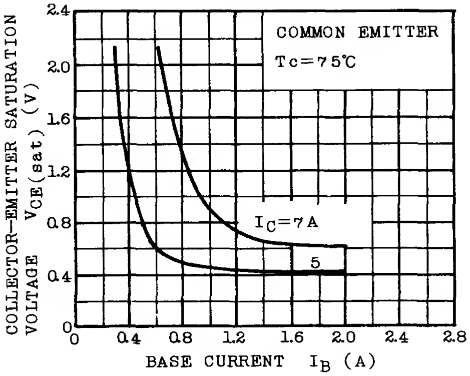
$V_{CE(sat)}$ — I_C



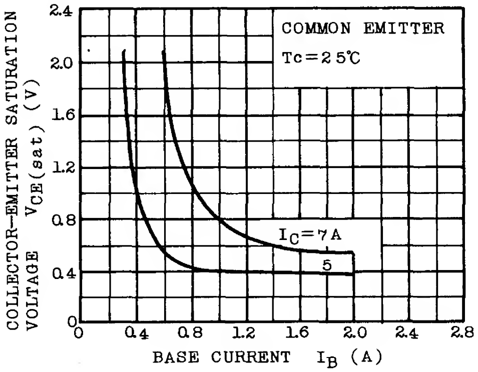
I_C — $V_{BE(sat)}$



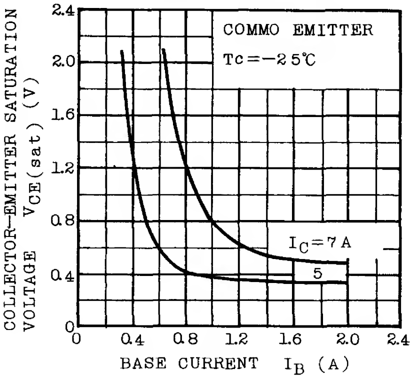
$V_{CE(sat)}$ — I_B



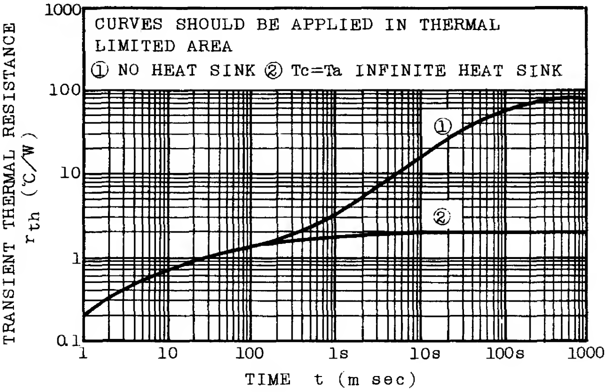
$V_{CE(sat)}$ — I_B



$V_{CE(sat)} - I_B$



$r_{th} - t$



(Fig.) t_f − Tc (Typical)

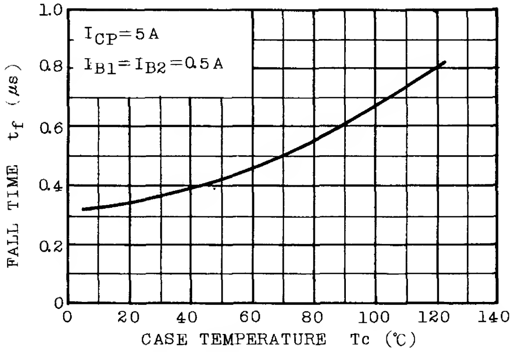
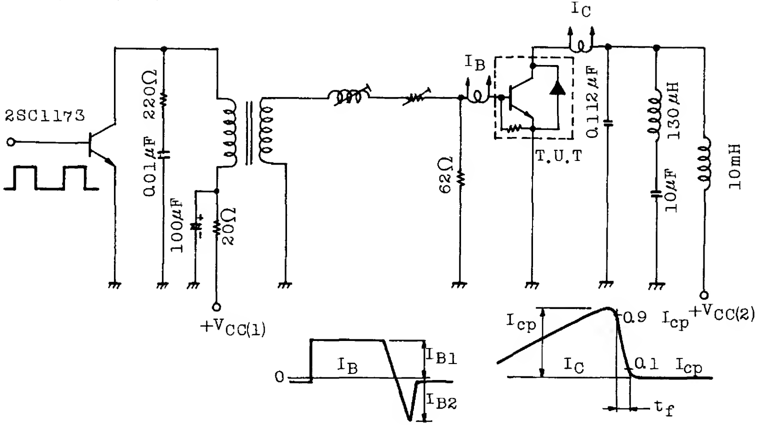


Fig. TEST CIRCUIT



SILICON NPN TRIPLE DIFFUSED MESA TYPE

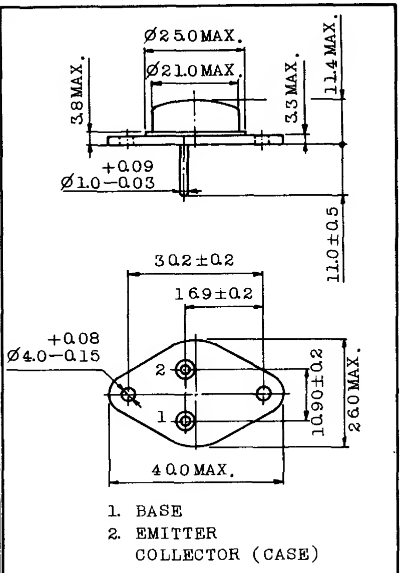
BU500

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=1V (Max.)
- Fall Time : t_f=0.7μs (Typ.)
- Glass Passivated Base-Collector Junction.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Mounting Kit No. AC42

Weight : 17.0g

MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc=95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-65 ~ 115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{BE}=0, V_{CE}=1500V	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_C=0, I_E=1mA	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, V_{CIC}=4.5A	2.25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4.5A, I_B=2A	-	-	1	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	-	-	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CE(SUS)}$	I_B=0, I_C=100mA, L=25mH	700	-	-	V
Transition Frequency (at f=5MHz)		f_T	V_{CE}=5V, V_{IC}=0.1A	-	7	-	MHz
Collector Output Capacitance (at f=1MHz)		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	125	-	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	0.7	-	μs
	Storage Time	t_s	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	10	-	μs

BUY

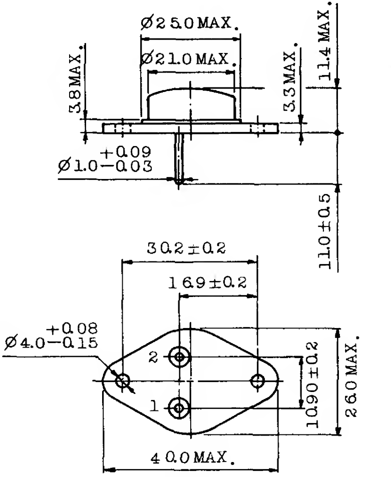
SERIES

SILICON NPN TRIPLE DIFFUSED MESA TYPE

BUY71

TV HORIZONTAL OUTPUT APPLICATION.

Unit in mm



1. BASE
2. EMITTER

COLLECTOR (CASE)

JEDEC	TO−3
EIAJ	TC−3, TB−3
TOSHIBA	2−21B1A

Weight : 17.0g

FEATURES:

. High Voltage : V_{CEX}=2200V

. Fast Switching : t_f=0.7μs (Typ.)

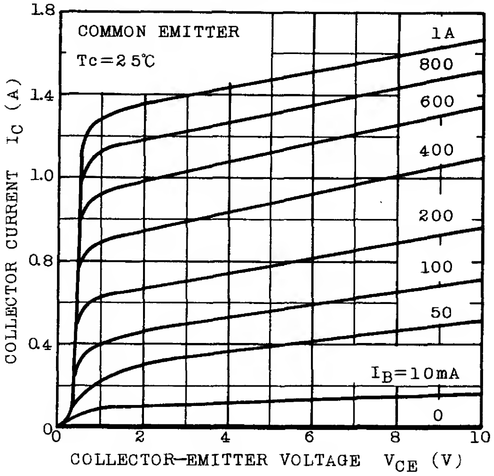
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	2200	V
Peak Collector-Emitter Voltage	V_{CEX}	2200	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc≦80°C)	P_C	10	W
Junction Temperature	T_j	100	°C
Storage Temperature Range	T_{stg}	-60～100	°C

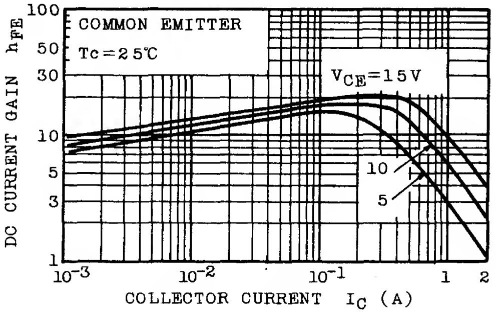
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Cut-off Current	I_{CEX}	V_{CE}=2200V, V_{BE}=-2V	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=100mA, I_C=0	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=1.5A, I_B=1.5A	-	-	10	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=1.5A, I_B=1.5A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.1A	-	4	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1.0MHz	-	50	-	pF
Fall Time	t_f	I_{cp}=1.2A $I_{B1(end)}$=0.55A	-	0.7	-	μs

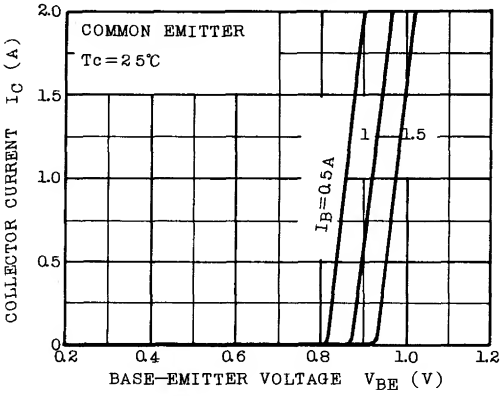
I_C – V_{CE} (LOW VOLTAGE REGION)

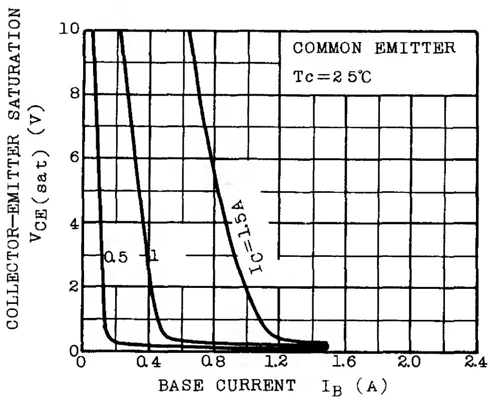


h_{FE} – I_C

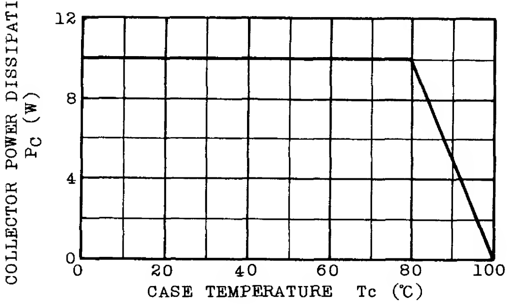


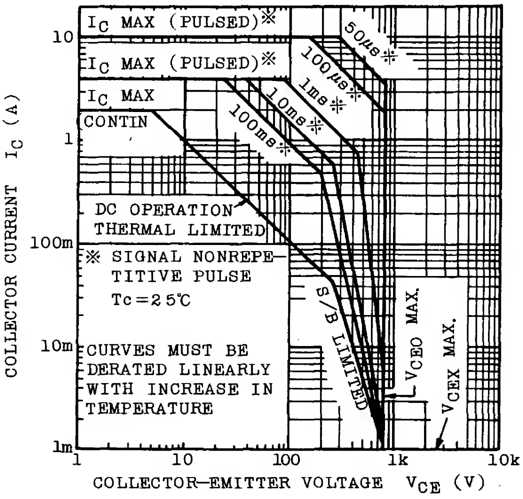
I_C – V_{BE}





P_C – Tc





TBF

SERIES

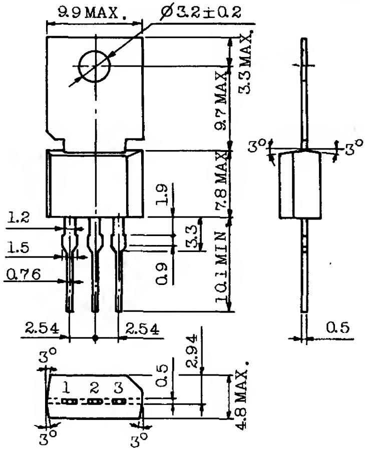
SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

TBF869
TBF871

HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

. PNP Complements are TBF870 and TBF872.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-202
EIAJ	–
TOSHIBA	2-10F1B

Weight : 1.4g

MAXIMUM RATINGS (Ta=25°C)

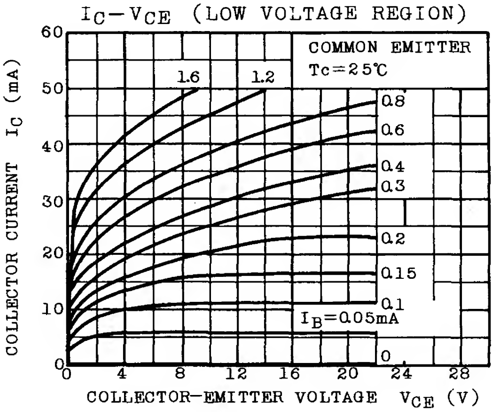
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	TBF869	V_{CBO}	250	V
	TBF871		300	
Collector-Emitter Voltage	TBF869	V_{CEO}	250	V
	TBF871		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	50	mA
	Peak	I_{CP}	100	
Total Power Dissipation		P_{tot}	1.6	W
			5.0 (Tc=25°C)	
Base Current		I_B	20	mA
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65 ~ 150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds		-	350	°C

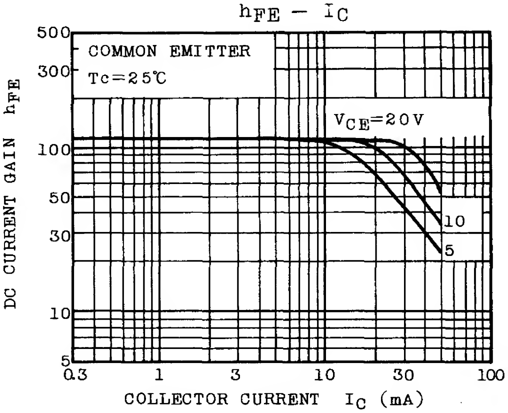
THERMAL CHARACTERISTICS

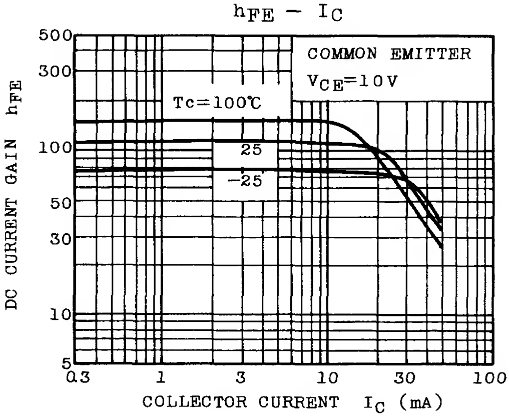
CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction-Ambient)	$R_{\theta JA}$	78.3	°C/W
Thermal Resistance (Junction-Case)	$R_{\theta JC}$	25	°C/W

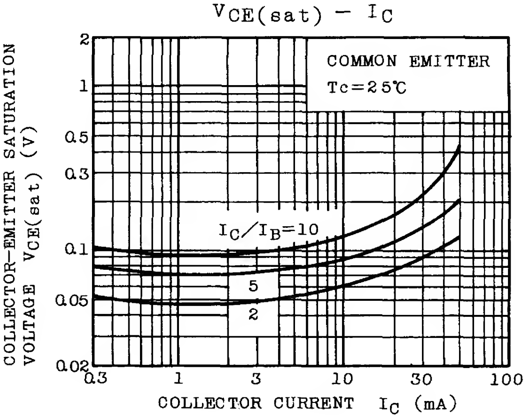
ELECTRICAL CHARACTERISTICS (Ta=25°C Unless otherwise specified)

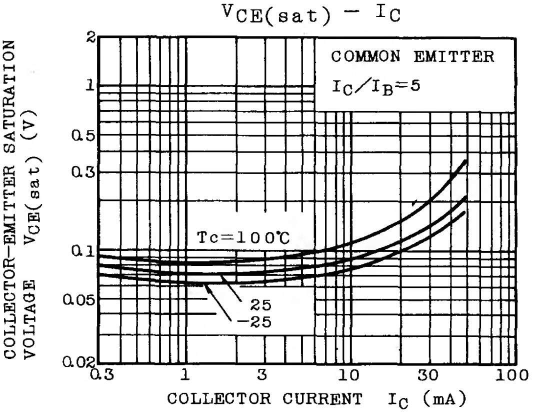
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	TBF869	I_{CBO}	V_{CB}=200V, I_E=0	-	-	0.1	μA
	TBF871	I_{CER}	V_{CE}=250V, R_{BE}=2.7kΩ	-	-	0.05	
Emitter Cut-off Current		I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	TBF869	$V_{(BR)CEO}$	I_C=1mA, I_B=0	250	-	-	V
	TBF871	$V_{(BR)CER}$	I_C=1μA, R_{BE}=2.7kΩ	300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	V_{CE}=200V, R_{BE}=2.7kΩ T_j=150°C	-	-	10	μA
DC Current Gain		h_{FE}	V_{CE}=20V, I_C=25mA	50	-	-	
Collector-Emitter RF Saturation Voltage		$V_{CE(sat)}$ RF	I_C=25mA, T_j=150°C	-	20	-	V
Base-Emitter Voltage		V_{BE}	V_{CE}=20V, I_C=25mA	-	0.75	-	V
Transition Frequency		f_T	V_{CE}=10V, I_C=10mA	60	100	-	MHz
Reverse Transfer Capacitance		C_{re}	V_{CB}=30V, I_E=0, f=1MHz	-	1.3	1.8	pF

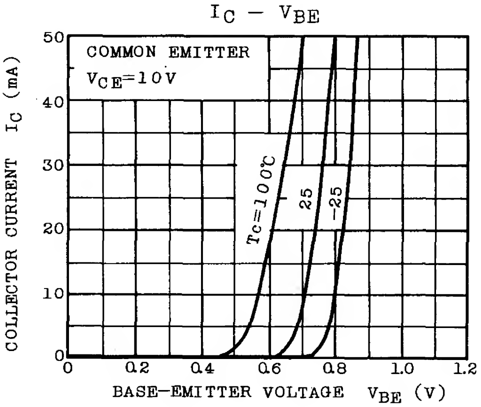

$I_C - V_{CE}$ (LOW VOLTAGE REGION)
COMMON EMITTER
Tc=25℃
1.6
1.2
0.8
0.6
0.4
0.3
0.2
0.15
0.1
I_B=0.05mA
0
COLLECTOR CURRENT I_C (mA)
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


$h_{FE} - I_C$
COMMON EMITTER
Tc=25℃
V_{CE}=20V
10
5
DC CURRENT GAIN h_{FE}
500
300
100
50
30
10
5
0.3
1
3
10
30
100
COLLECTOR CURRENT I_C (mA)

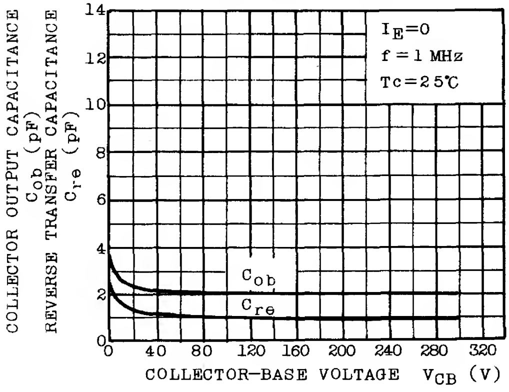

$h_{FE} - I_C$
COMMON EMITTER
V_{CE}=10V
Tc=100℃
25
-25
DC CURRENT GAIN h_{FE}
500
300
100
50
30
10
5
0.3
1
3
10
30
100
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_C$
COMMON EMITTER
Tc=25℃
I_C/I_B=10
5
2
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
2
1
0.5
0.3
0.1
0.05
0.02
0.3
1
3
10
30
100
COLLECTOR CURRENT I_C (mA)

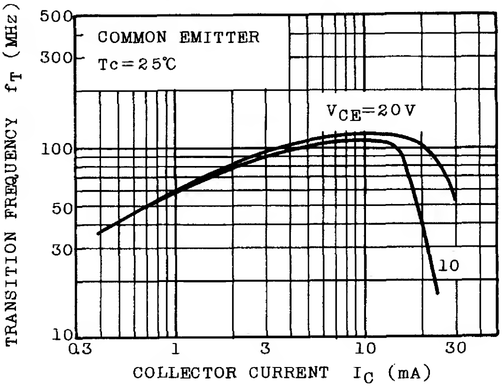

$V_{CE(sat)} - I_C$
COMMON EMITTER
I_C/I_B=5
Tc=100℃
25
-25
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
2
1
0.5
0.3
0.1
0.05
0.02
0.3
1
3
10
30
100
COLLECTOR CURRENT I_C (mA)


$I_C - V_{BE}$
COMMON EMITTER
V_{CE}=10V
Tc=100℃
25
-25
COLLECTOR CURRENT I_C (mA)
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1.0
1.2
BASE-EMITTER VOLTAGE V_{BE} (V)

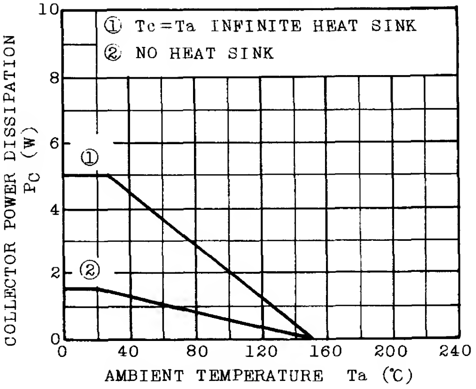
$C_{ob}, C_{re} - V_{CB}$



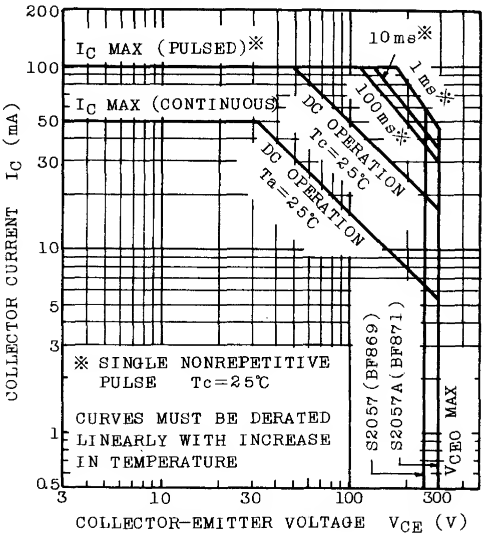
$f_T - I_C$



$P_C - Ta$



SAFE OPERATING AREA



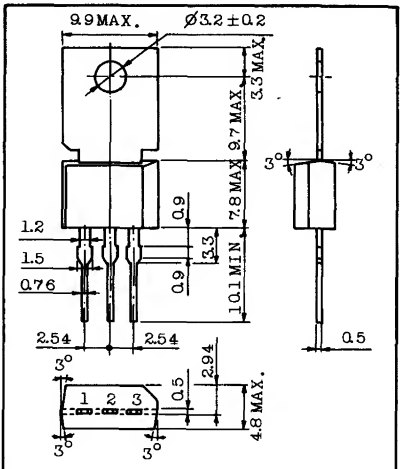
SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

TBF870
TBF872

HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

- NPN Complements are TBF869 and TFB871.

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-202
EIAJ	—
TOSHIBA	2-10F1B

Weight : 1.4g

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	TBF870	V_{CBO}	-250	V
	TBF872		-300	
Collector-Emitter Voltage	TBF870	V_{CEO}	-250	V
	TBF872		-300	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current	DC	I_C	-50	mA
	Peak	I_{CP}	-100	
Total Power Dissipation		P_{tot}	1.6	W
			5.0 ($T_c=25^\circ C$)	
Base Current		I_B	-20	mA
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65 ~ 150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds		-	350	°C

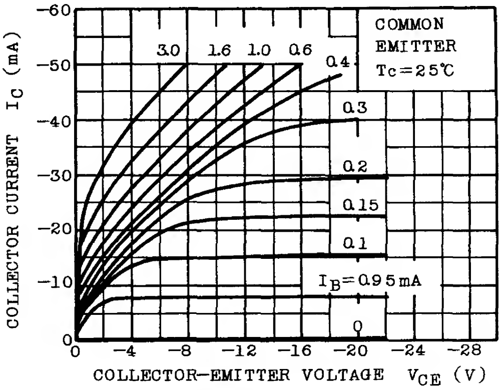
THERMAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction-Ambient)	$R_{\theta JA}$	78.3	°C/W
Thermal Resistance (Junction-Case)	$R_{\theta JC}$	25	°C/W

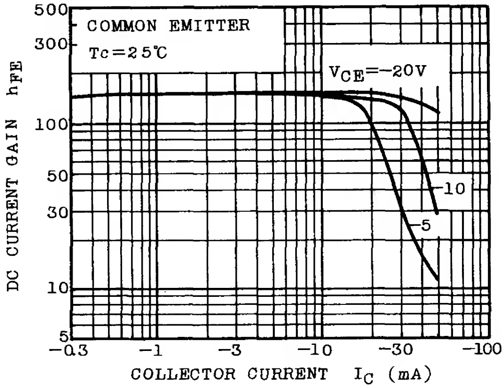
ELECTRICAL CHARACTERISTICS (Ta=25°C Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	TBF870	I_{CBO}	V_{CB}=-200V, I_E=0	-	-	-0.1	μA
	TBF872	I_{CER}	V_{CE}=-250V, R_{BE}=2.7kΩ	-	-	-0.05	
Emitter Cut-off Current		I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	TBF870	$V_{(BR)CEO}$	I_C=-1mA, I_B=0	-250	-	-	V
	TBF872	$V_{(BR)CER}$	I_C=-1μA, R_{BE}=2.7kΩ	-300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	V_{CE}=-200V, R_{BE}=2.7kΩ T_j=150°C	-	-	-10	μA
DC Current Gain		h_{FE}	V_{CE}=-20V, I_C=-25mA	50	-	-	
Collector-Emitter RF Saturation Voltage		$V_{CE(sat)\,RF}$	I_C=-25mA, T_j=150°C	-	-20	-	V
Base-Emitter Voltage		V_{BE}	V_{CE}=-20V, I_C=-25mA	-	-0.75	-	V
Transition Frequency		f_T	V_{CE}=-10V, I_C=-10mA	60	80	-	MHz
Reverse Transfer Capacitance		C_{re}	V_{CB}=-30V, I_E=0, f=1MHz	-	1.7	2.0	pF

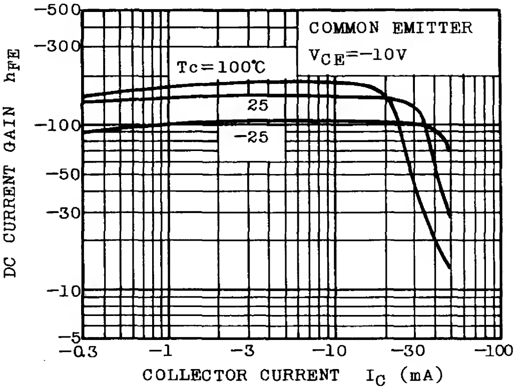
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



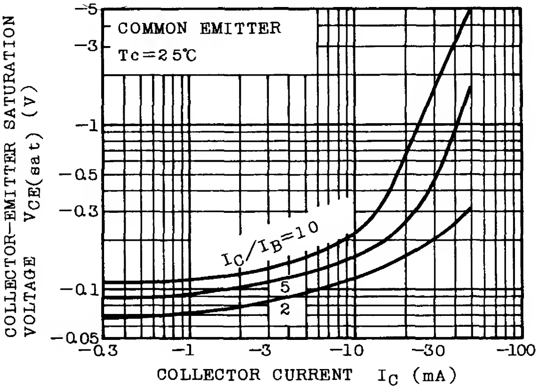
$h_{FE} - I_C$



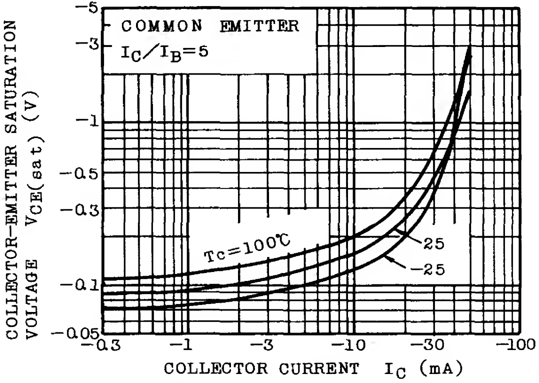
$h_{FE} - I_C$



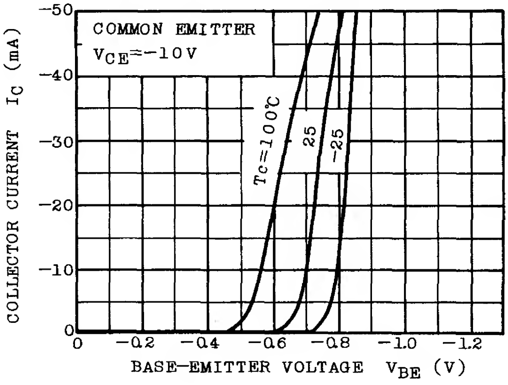
$V_{CE(sat)} - I_C$



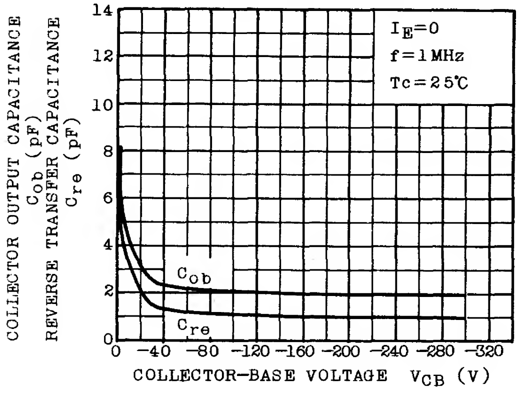
$V_{CE(sat)} - I_C$



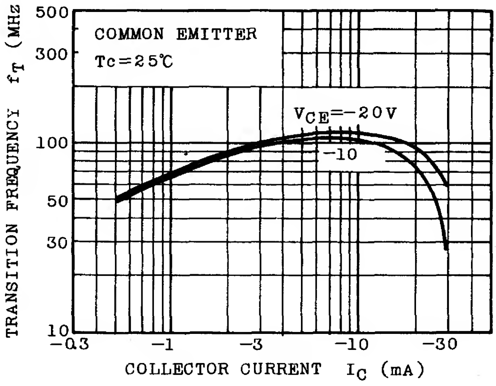
$I_C - V_{BE}$



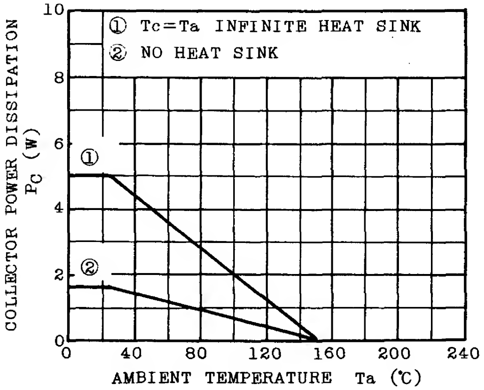
$C_{ob}, C_{re} - V_{CB}$



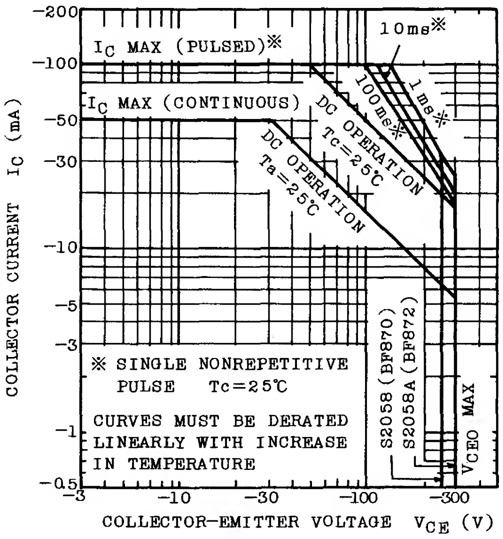
$f_T - I_C$



$P_C - Ta$



SAFE OPERATING AREA



TSB

SERIES

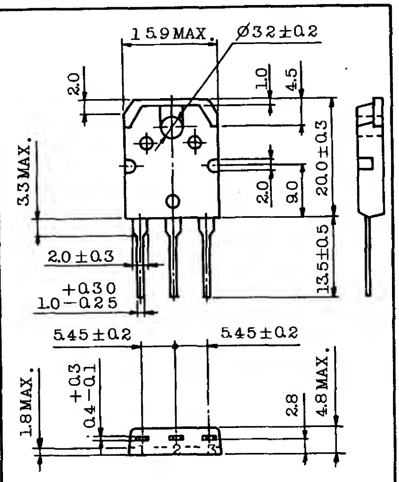
SILICON NPN TRIPLE DIFFUSED TYPE

TSB3055

GENERAL PURPOSE TRANSISTOR
POWER REGULATOR, SWITCHING AND SOLENOID
DRIVE APPLICATIONS.

FEATURES:
- Convenient MOLD Package : Useless Insulation Bushing
- High Gain at High Current
  : h_{FE}=20 ~ 100 @ V_{CE}=4V, I_C=4A
- Low Saturation Voltage
  : $V_{CE(sat)}$ <1.1V @ I_C=4A, I_B=0.4A

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	−
EIAJ	−
TOSHIBA	2−16B1A

Weight : 4.6g

Notice ; Maximum torque applied to mounting flange is 8 kg·cm

MAXIMUM RATINGS (T_a=25°C)

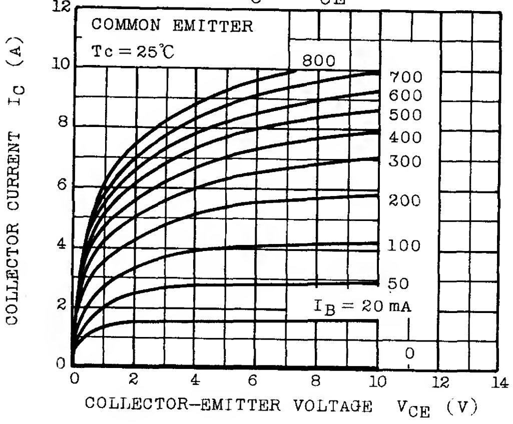
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	6	A
Collector Power Dissipation (T_c=25°C) Derate above 25°C	P_C	70	W
		0.56	W/°C
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	−55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

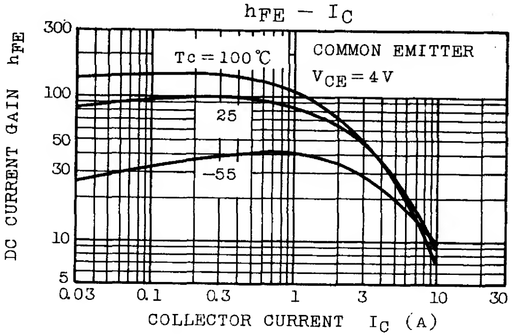
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CEX}	V_{CE}=80V, V_{BE}=−1.5V	−	−	1.0	mA
Collector Cut-off Current	I_{CEO}	V_{CE}=80V, I_B=0	−	−	0.7	mA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	−	−	5	mA
Collector-Emitter Sustaining Voltage	※ $V_{CEO(SUS)}$	I_C=200mA, I_B=0	80	−	−	V
DC Current Gain	h_{FE}	V_{CE}=4V, I_C=4A	20	−	100	
		V_{CE}=4V, I_C=10A	5	−	−	
Base-Emitter Voltage	V_{BE}	V_{CE}=4V, I_C=4A	−	−	1.8	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=4A, I_B=0.4A	−	−	1.1	V
		I_C=10A, I_B=3.3A	−	−	8.0	
Transition Frequency	f_T	V_{CE}=10V, I_C=0.5A, f=1MHz	3.0	8.0	−	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	−	70	−	pF

※ The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

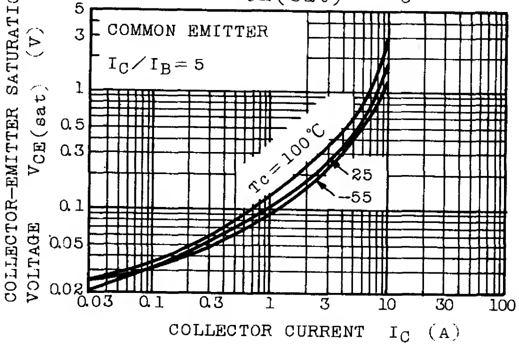
I_C – V_{CE}



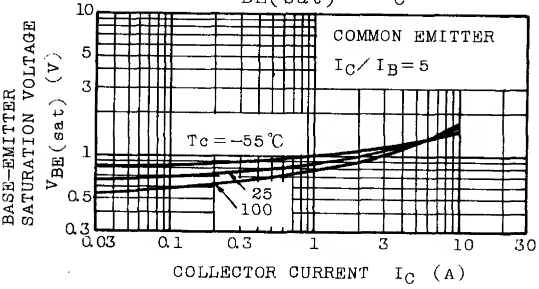
h_{FE} – I_C



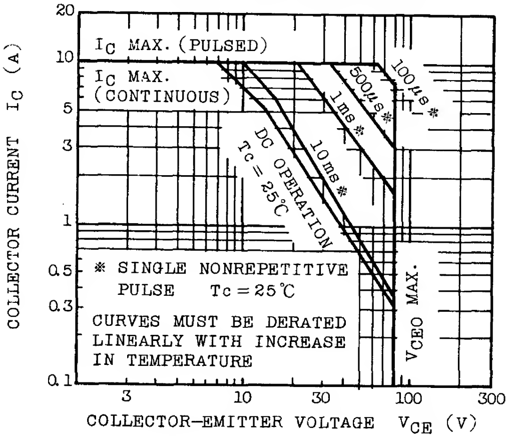
$V_{CE(sat)}$ – I_C



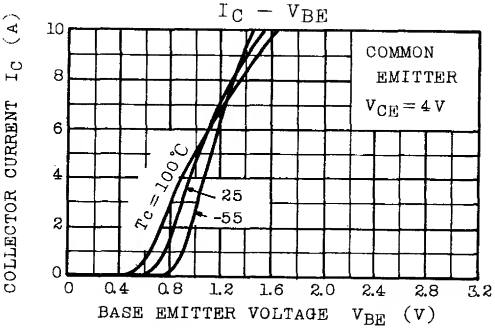
$V_{BE(sat)}$ – I_C



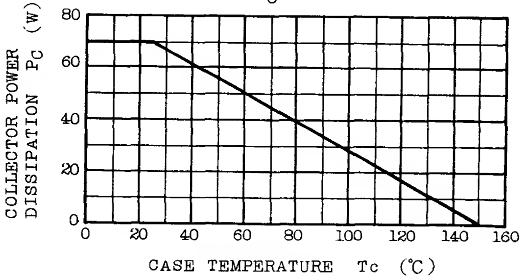
SAFE OPERATING AREA



I_C – V_{BE}



P_C – Tc



S

SERIES

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

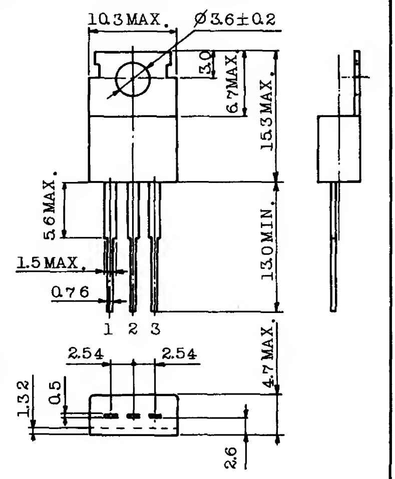
S1236

POWER AMPLIFIER APPLICATIONS.
TV VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to S1237

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO-220AB
EIAJ	SC-46
TOSHIBA	2-10A1A

Mounting Kit No. AC75

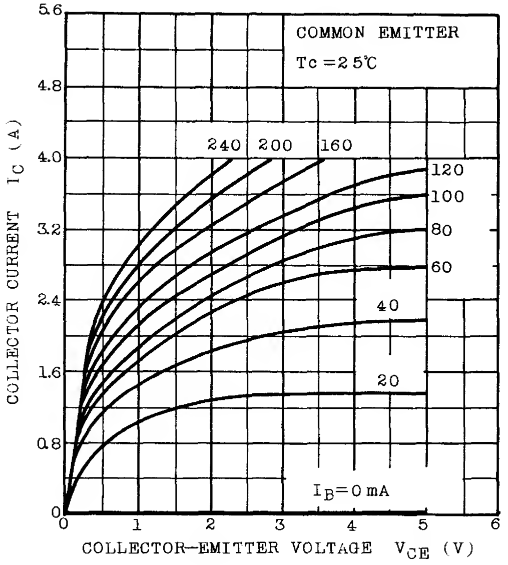
Weight : 1.9g

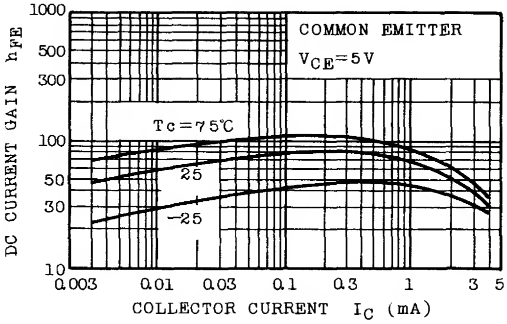
MAXIMUM RATINGS (Ta=25°C)

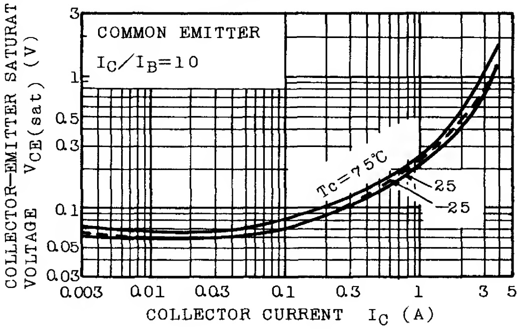
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	90	V
Collector-Emitter Voltage	V_{CEO}	90	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	-55~150	°C

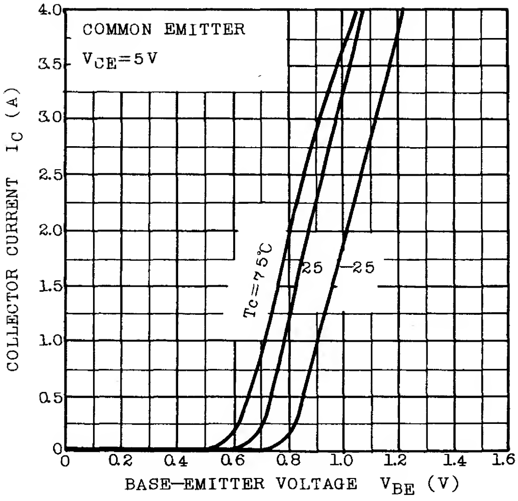
ELECTRICAL CHARACTERISTICS (Ta=25°C)

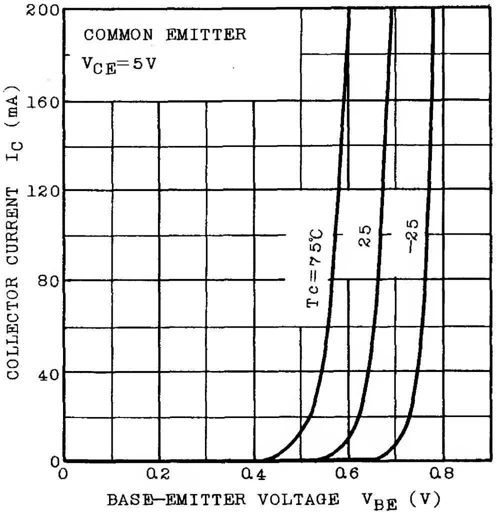
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=90V, I_E=0	-	-	20	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=50mA, I_B=0	90	-	-	V
DC Current Gain	$h_{FE(1)}$	V_{CE}=5V, I_C=0.5A	40	-	200	
	$h_{FE(2)}$	V_{CE}=5V, I_C=3A	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=5V, I_C=3A	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_C=0.5A	3	8	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	85	-	pF

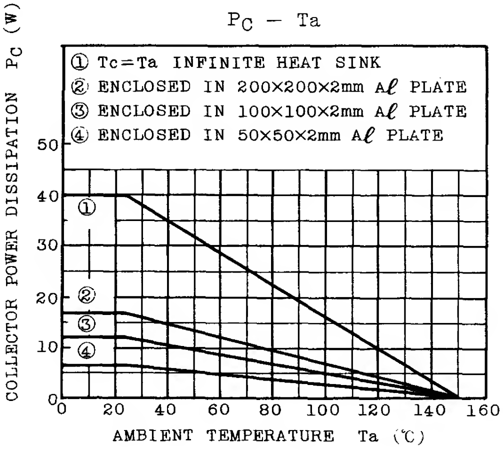

I_C – V_{CE}

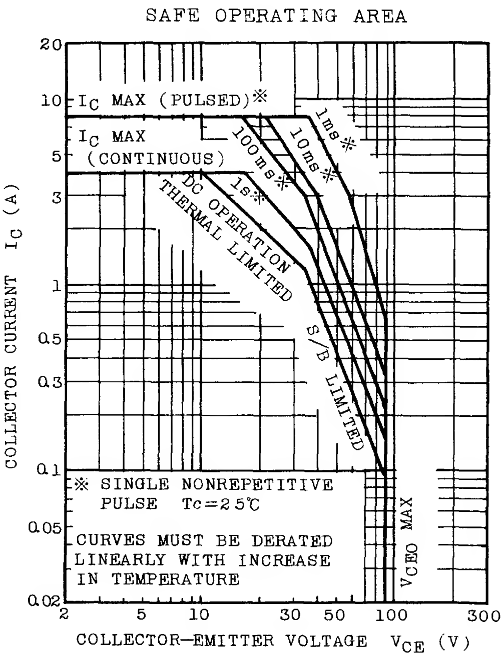

h_{FE} – I_C


$V_{CE(sat)}$ – I_C


I_C – V_{BE}


I_C – V_{BE}


PC − Ta
① Tc=Ta INFINITE HEAT SINK
② ENCLOSED IN 200×200×2mm Aℓ PLATE
③ ENCLOSED IN 100×100×2mm Aℓ PLATE
④ ENCLOSED IN 50×50×2mm Aℓ PLATE
COLLECTOR POWER DISSIPATION PC (W)
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
AMBIENT TEMPERATURE Ta (℃)
①
②
③
④


SAFE OPERATING AREA
IC MAX (PULSED)※
IC MAX (CONTINUOUS)
1ms※
10ms※
100ms※
1s※
DC OPERATION
THERMAL LIMITED
S/B LIMITED
VCEO MAX
※ SINGLE NONREPETITIVE PULSE Tc=25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
20
10
5
3
1
0.5
0.3
0.1
0.05
0.02
2
5
10
30
50
100
300
COLLECTOR−EMITTER VOLTAGE VCE (V)

S1237

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

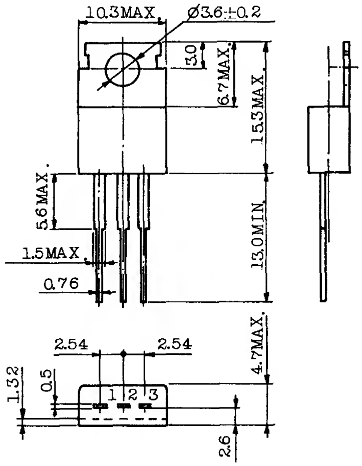
POWER AMPLIFIER APPLICATIONS.

TV VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to S1236

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC	TO−220AB
EIAJ	SC−46
TOSHIBA	2−10A1A

Mounting Kit No. AC75

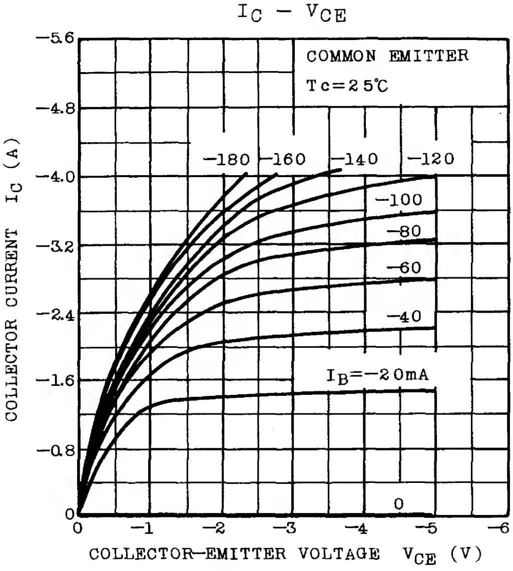
Weight : 1.9g

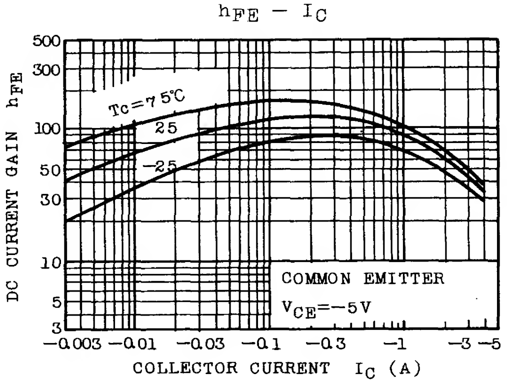
MAXIMUM RATINGS (Ta=25°C)

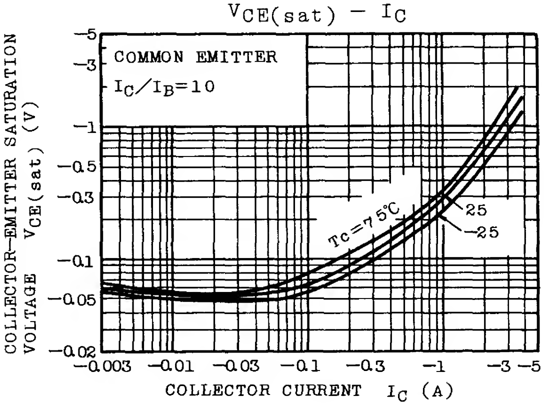
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-90	V
Collector-Emitter Voltage	V_{CEO}	-90	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-4	A
Emitter Current	I_E	4	A
Base Current	I_B	-3	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

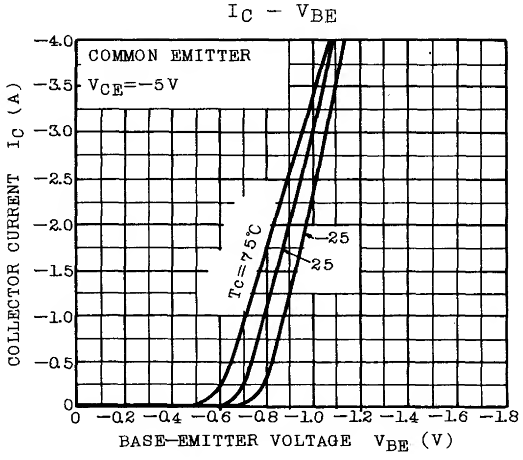
ELECTRICAL CHARACTERISTICS (Ta=25°C)

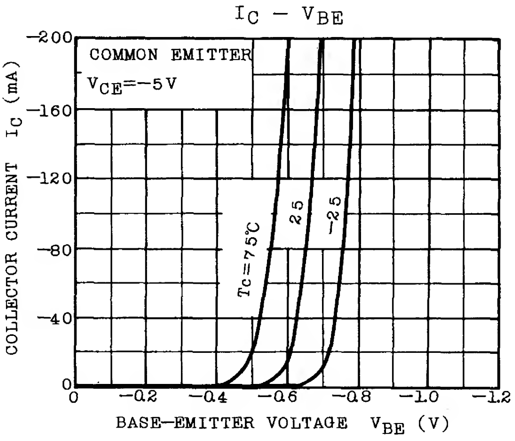
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-90 V, I_E=0	-	-	-20	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-50mA, I_B=0	-90	-	-	V
DC Current Gain	$h_{FE(1)}$	V_{CE}=-5V, I_C=-0.5A	40	-	200	
	$h_{FE(2)}$	V_{CE}=-5V, I_C=-3A	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-3A, I_B=-0.3A	-	-	-1.7	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-5V, I_C=-3A	-	-	-1.5	V
Transition Frequency	f_T	V_{CE}=-5V, I_C=-0.5A	3	5	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	130	-	pF


I_C – V_{CE}
COMMON EMITTER
Tc=25°C
−180
−160
−140
−120
−100
−80
−60
−40
I_B=−20mA
0
COLLECTOR CURRENT I_C (A)
−5.6
−4.8
−4.0
−3.2
−2.4
−1.6
−0.8
0
0
−1
−2
−3
−4
−5
−6
COLLECTOR–EMITTER VOLTAGE V_{CE} (V)

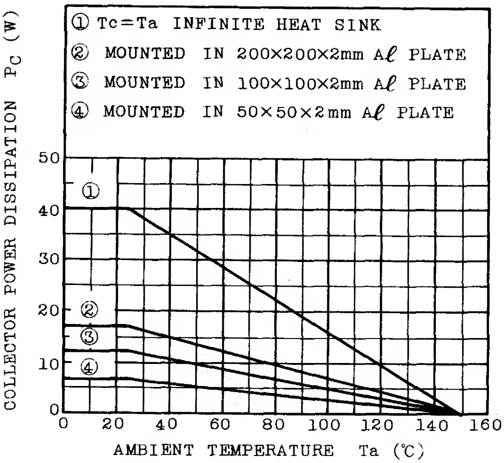

h_{FE} – I_C
Tc=75°C
25
−25
COMMON EMITTER
V_{CE}=−5V
DC CURRENT GAIN h_{FE}
500
300
100
50
30
10
5
3
−0.003
−0.01
−0.03
−0.1
−0.3
−1
−3
−5
COLLECTOR CURRENT I_C (A)


$V_{CE(sat)}$ – I_C
COMMON EMITTER
I_C/I_B=10
Tc=75°C
25
−25
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
−5
−3
−1
−0.5
−0.3
−0.1
−0.05
−0.02
−0.003
−0.01
−0.03
−0.1
−0.3
−1
−3
−5
COLLECTOR CURRENT I_C (A)

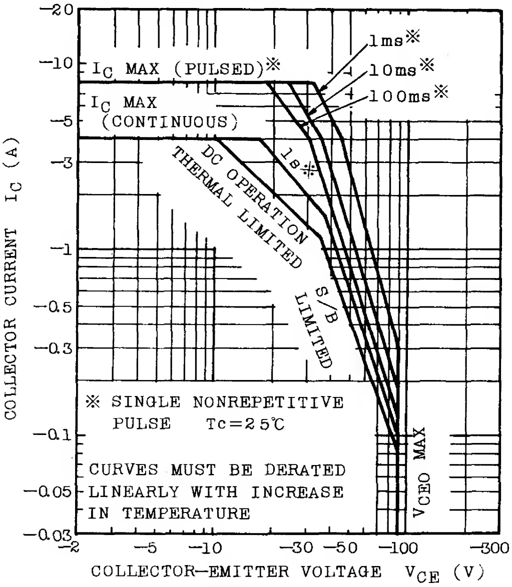

I_C – V_{BE}
COMMON EMITTER
V_{CE}=−5V
Tc=75°C
−25
25
COLLECTOR CURRENT I_C (A)
−4.0
−3.5
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0
0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−1.8
BASE–EMITTER VOLTAGE V_{BE} (V)


I_C – V_{BE}
COMMON EMITTER
V_{CE}=−5V
Tc=75°C
25
−25
COLLECTOR CURRENT I_C (mA)
−200
−160
−120
−80
−40
0
0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
BASE–EMITTER VOLTAGE V_{BE} (V)

Pc — Ta



SAFE OPERATING AREA



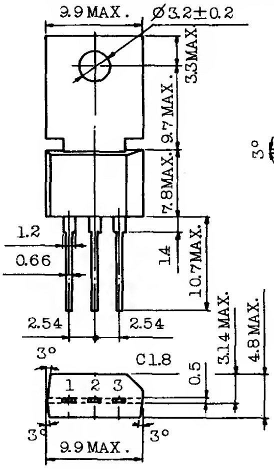
S1298

COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Collector-Emitter Breakdown Voltage : V_{CEO}=300V
- Low C_{cb} (2.5pF Typ.)

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	TO-202
EIAJ	—
TOSHIBA	2-10D1A

Weight : 1.4g

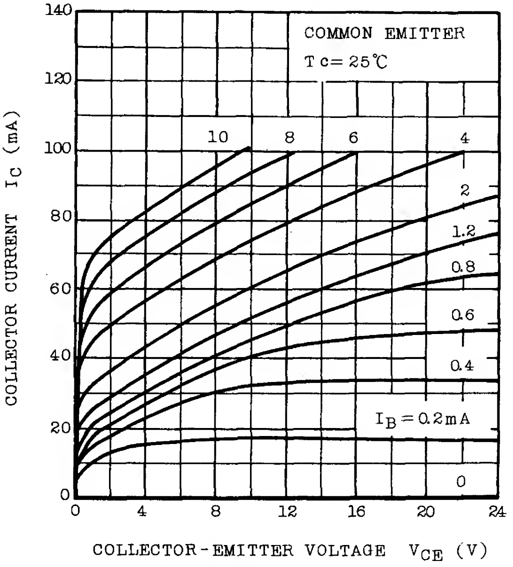
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	300	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	100	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		6.25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55～150	°C

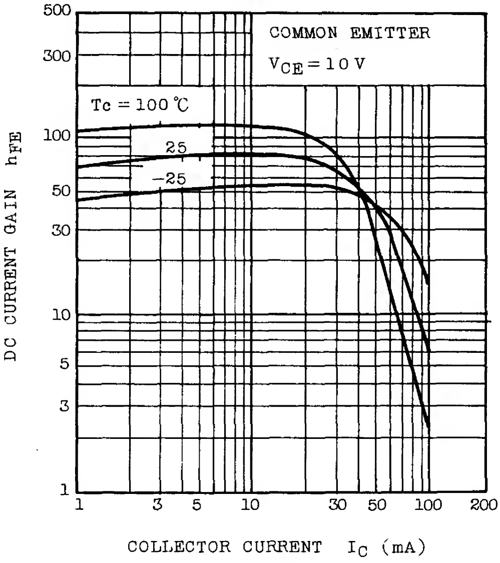
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=300V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=7V, I_C=0	-	-	10	μA
DC Current Gain	$h_{FE(1)}$	V_{CE}=10V, I_C=4mA	20	-	-	
	$h_{FE(2)}$	V_{CE}=10V, I_C=20mA	30	-	150	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=10mA, I_B=1mA	-	-	1.0	V
Transition Frequency	f_T	V_{CE}=10V, I_C=20mA	50	70	-	MHz
Collector-Base Capacitance	C_{cb}	V_{CB}=20V, I_E=0, f=1MHz	-	2.5	3.0	pF

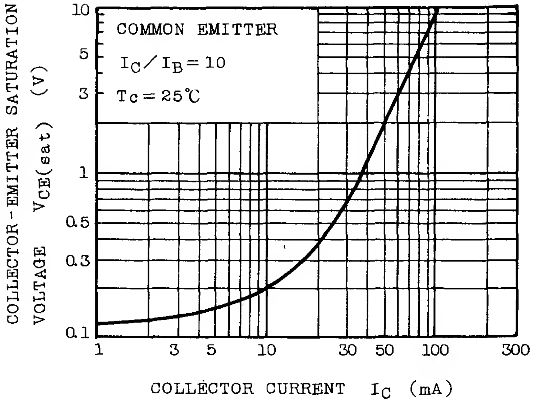
$I_C - V_{CE}$



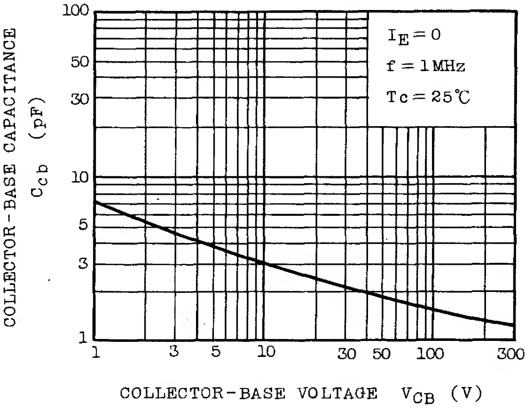
$h_{FE} - I_C$

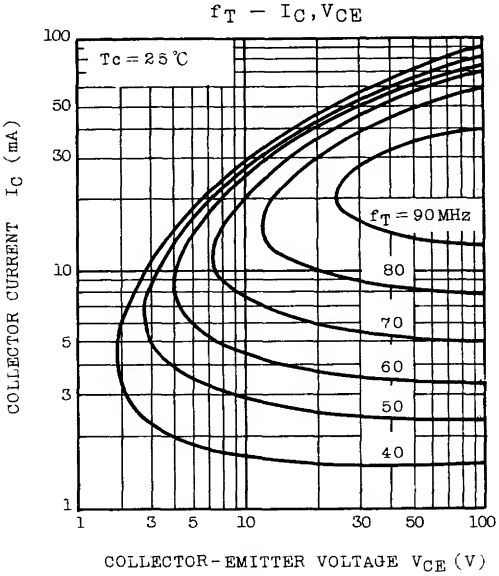


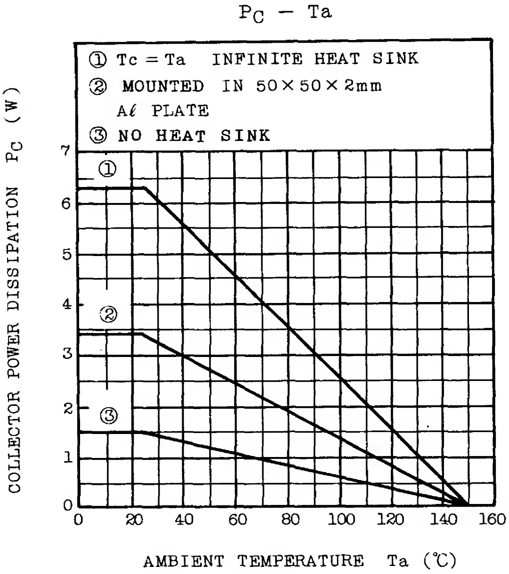
$V_{CE(sat)} - I_C$



$C_{cb} - V_{CB}$




fT − IC,VCE
Tc = 25℃
fT = 90 MHz
80
70
60
50
40
100
50
30
10
5
3
1
1
3
5
10
30
50
100
COLLECTOR CURRENT IC (mA)
COLLECTOR-EMITTER VOLTAGE VCE (V)


PC − Ta
① Tc = Ta INFINITE HEAT SINK
② MOUNTED IN 50×50×2mm Aℓ PLATE
③ NO HEAT SINK
①
②
③
7
6
5
4
3
2
1
0
0
20
40
60
80
100
120
140
160
COLLECTOR POWER DISSIPATION PC (W)
AMBIENT TEMPERATURE Ta (℃)

S1375

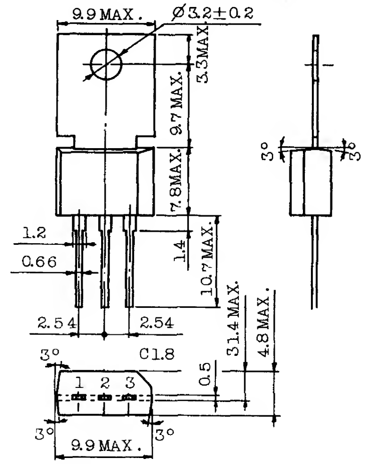
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

. Complementary to S1376

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	―
EIAJ	―
TOSHIBA	2-10D1A

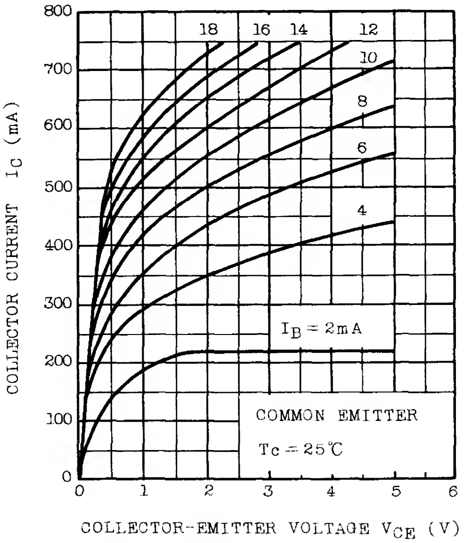
Weight : 1.4g

MAXIMUM RATINGS (Ta=25°C)

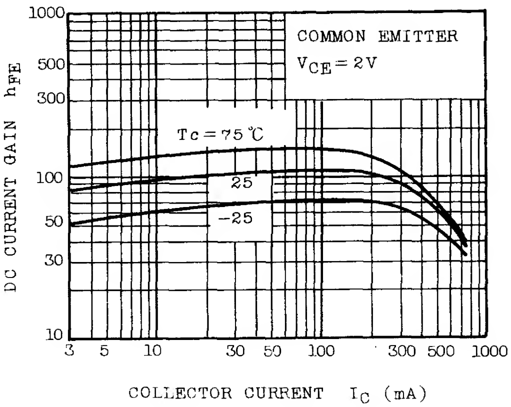
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	750	mA
Base Current	I_B	500	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

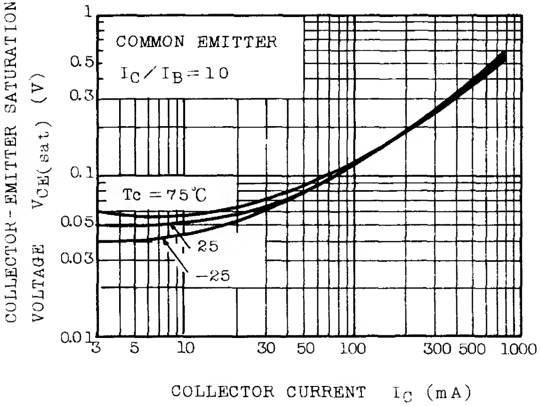
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=30V, I_E=0	-	-	0.5	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	80	-	-	V
DC Current Gain	$h_{FE(1)}$	V_{CE}=2V, I_C=150mA	70	-	240	
	$h_{FE(2)}$	V_{CE}=2V, I_C=500mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	0.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=2V, I_C=500mA	-	-	1.0	V
Transition Frequency	f_T	V_{CE}=2V, I_C=150mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	15	-	pF



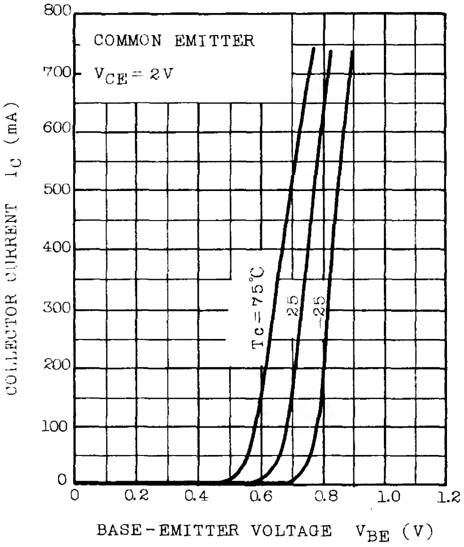
$I_C - V_{CE}$



$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$I_C - V_{BE}$

S1376

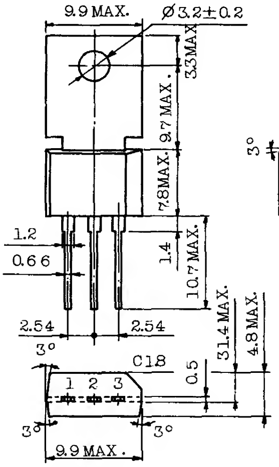
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to S1375

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	—
EIAJ	—
TOSHIBA	2-10D1A

Weight : 1.4g

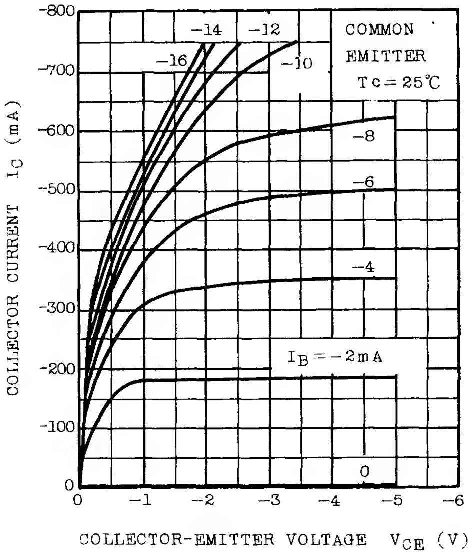
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-750	mA
Base Current	I_B	-500	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

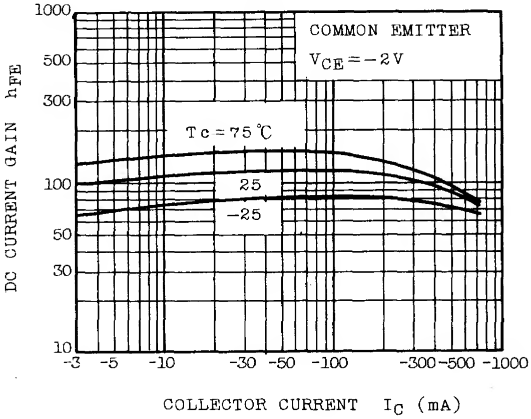
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-30V, I_E=0	-	-	-0.5	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	80	-	-	V
DC Current Gain	$h_{FE}(1)$	V_{CE}=-2V, I_C=-150mA	70	-	240	
	$h_{FE}(2)$	V_{CE}=-2V, I_C=-500mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-500mA, I_B=-50mA	-	-	-0.5	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-2V, I_C=-500mA	-	-	-1.0	V
Transition Frequency	f_T	V_{CE}=-2V, I_C=-150mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	20	-	pF

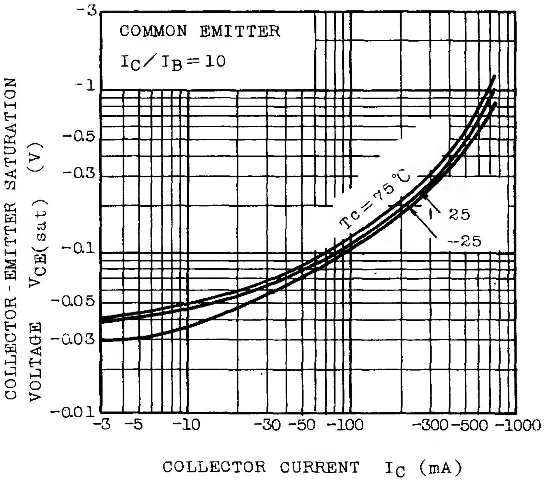
$I_C - V_{CE}$



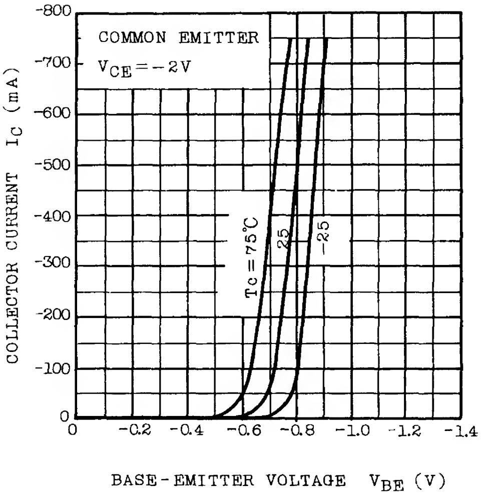
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



$I_C - V_{BE}$



S1377

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

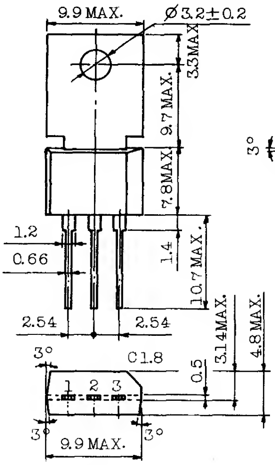
MEDIUM POWER AMPLIFIER APPLICATIONS.
TV HORIZONTAL DRIVER APPLICATIONS.

FEATURES:

. High Collector to Emitter Breakdown Voltage

$V_{CEO}=250V$

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	―
EIAJ	―
TOSHIBA	2-10D1A

Weight : 1.4g

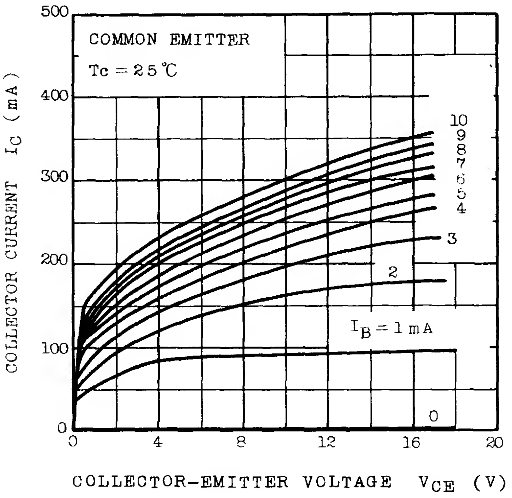
MAXIMUM RATINGS $(Ta=25^{\circ}C)$

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	250	V
Collector-Emitter Voltage		V_{CEO}	250	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	500	mA
Base Current		I_B	250	mA
Collector Power Dissipation	$Ta=25^{\circ}C$	P_C	1.5	W
	$Tc=25^{\circ}C$		6.25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

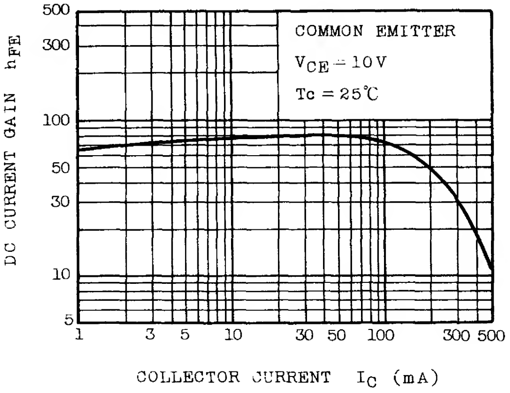
ELECTRICAL CHARACTERISTICS $(Ta=25^{\circ}C)$

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=250V,\ I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V,\ I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA,\ I_B=0$	250	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V,\ I_C=100mA$	30	-	200	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=200mA,\ I_B=20mA$	-	-	3	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=200mA,\ I_B=20mA$	-	-	1.2	V
Transition Frequency	f_T	$V_{CE}=10V,\ I_C=100mA$	40	60	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=20V,\ I_E=0,\ f=1MHz$	-	-	7	pF

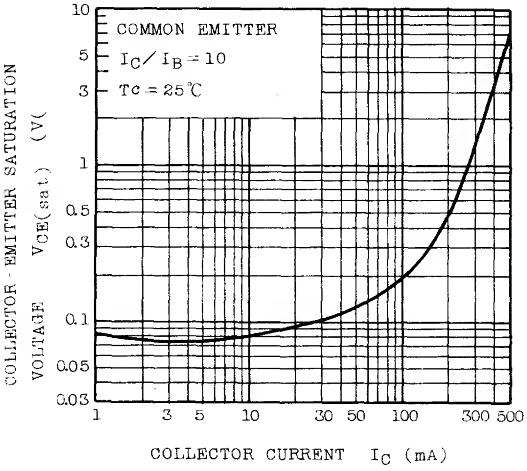
$I_C - V_{CE}$



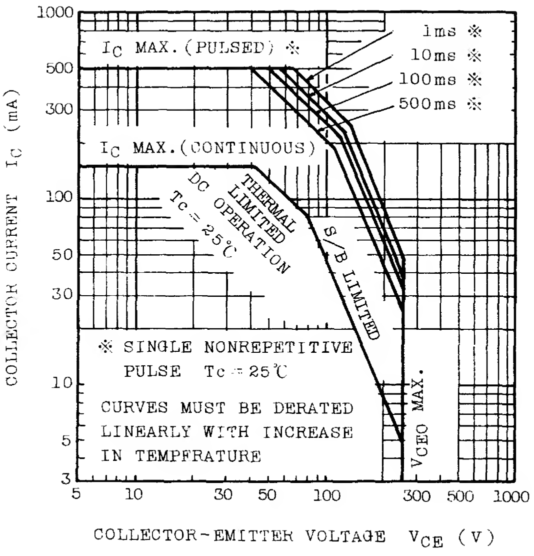
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



SAFE OPERATING AREA

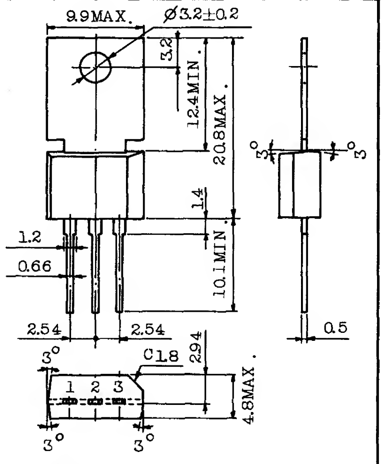


S1732

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
TV HORIZONTAL DRIVER APPLICATIONS.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	TO-202
EIAJ	—
TOSHIBA	2-10F1A

Weight : 1.4g

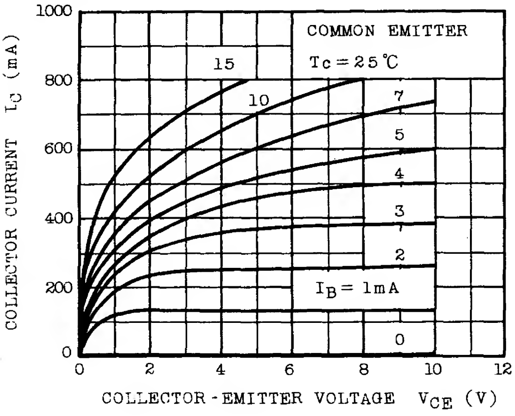
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	200	V
Collector-Emitter Voltage		V_{CEO}	120	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	800	mA
Base Current		I_B	500	mA
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		6.25	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

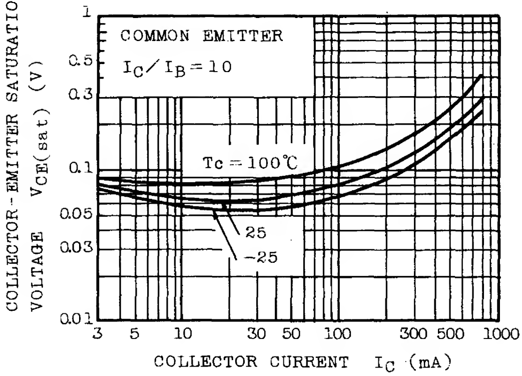
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=200V, I_E=0	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=6V, I_C=0	-	-	1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	120	-	-	V
DC Current Gain	$h_{FE(1)}$	V_{CE}=5V, I_C=100mA	60	-	250	
	$h_{FE(2)}$	V_{CE}=5V, I_C=400mA	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=500mA, I_B=50mA	-	-	1	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=500mA, I_B=50mA	-	-	1.5	V
Transition Frequency	f_T	V_{CE}=5V, I_E=100mA	30	50	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	-	30	pF

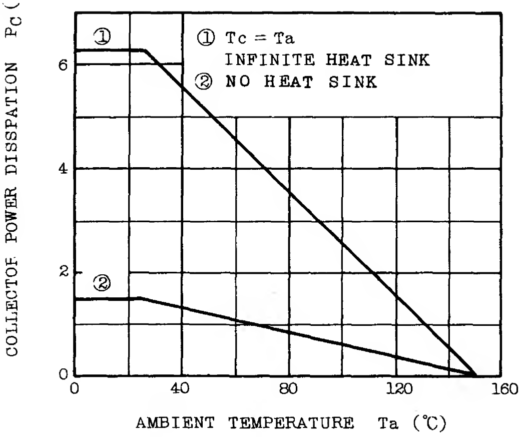
$I_C - V_{CE}$



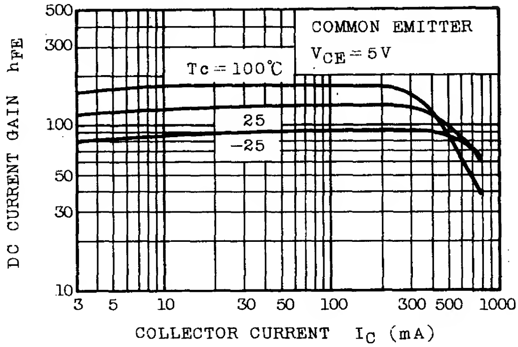
$V_{CE(sat)} - I_C$



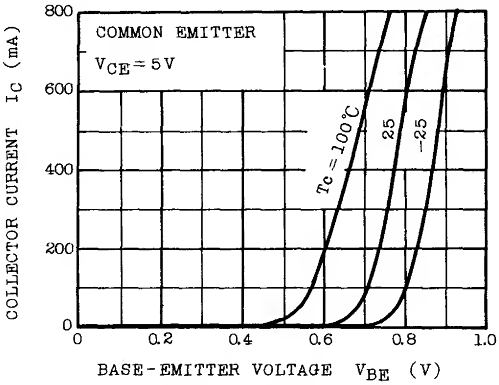
$P_C - Ta$



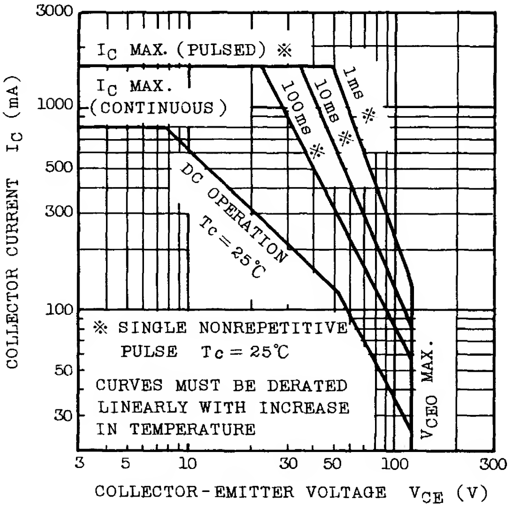
$h_{FE} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA



S1954

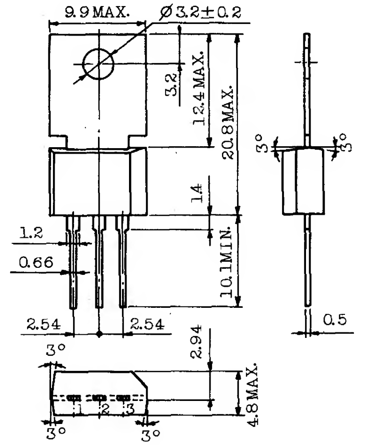
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Suitable for TV Sound Output, Vert. Deflection Output.
- Designed for Complementary Use with S1955.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	TO−202
EIAJ	−
TOSHIBA	2−10F1A

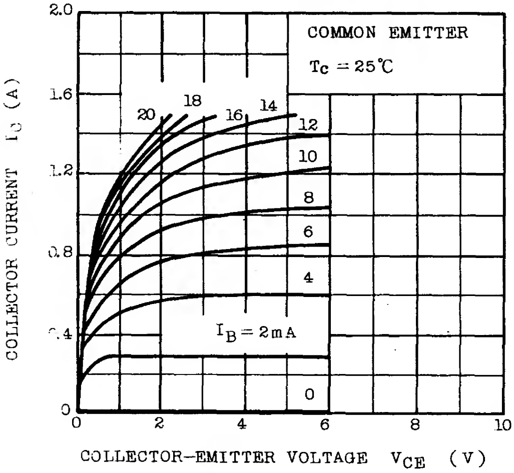
Weight : 1.4g

MAXIMUM RATINGS (Ta=25°C)

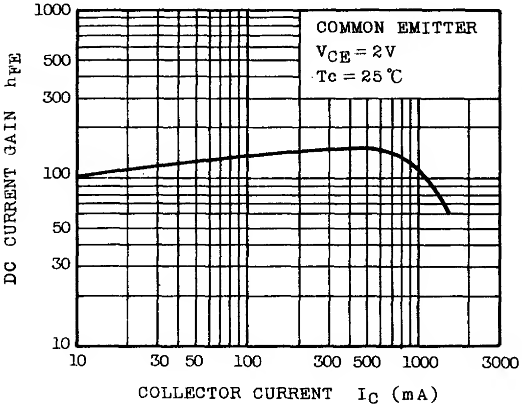
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	1.5	A
Emitter Current	I_E	-1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

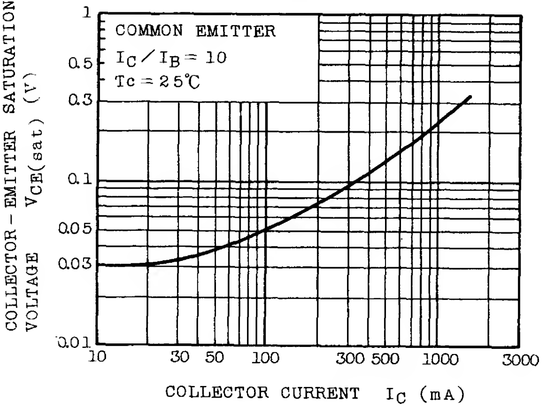
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=50V, I_E=0	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=5V, I_C=0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=10mA, I_B=0	50	-	-	V
DC Current Gain	h_{FE}	V_{CE}=2V, I_C=150mA	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=1A, I_B=0.1A	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=10V, I_C=10mA	0.50	0.60	0.70	V
Transition Frequency	f_T	V_{CE}=10V, I_C=100mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	20	-	pF



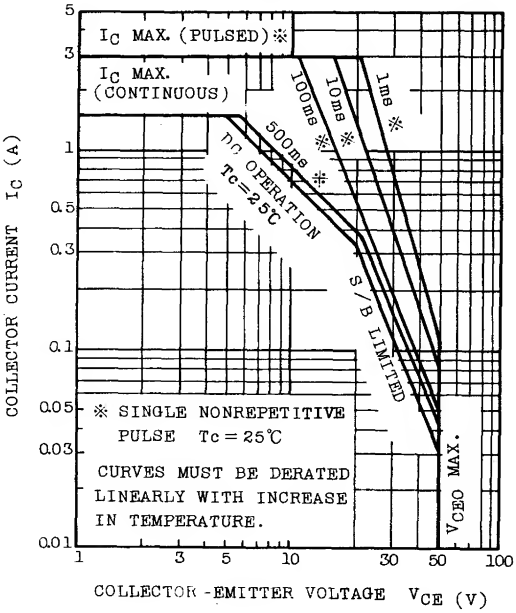
$I_C - V_{CE}$



$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



SAFE OPERATING AREA

S1955

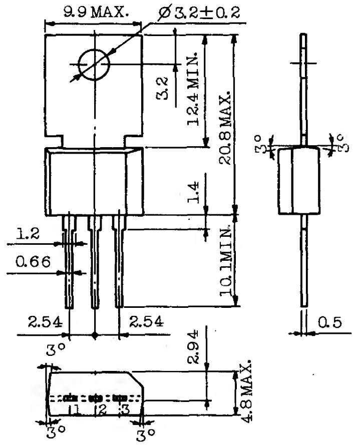
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Suitable for TV Sound Output, Vert. Deflection Output.
- Designed for Complementary Use with S1954.

Unit in mm



1. EMITTER
2. BASE
3. COLLECTOR (HEAT SINK)

JEDEC	TO−202
EIAJ	−
TOSHIBA	2−10F1A

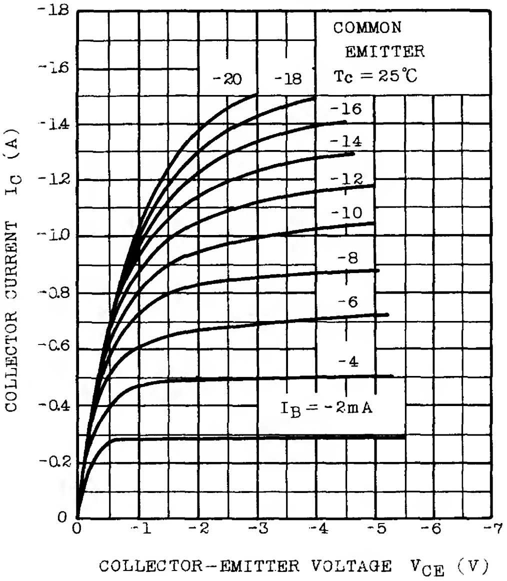
Weight : 1.4g

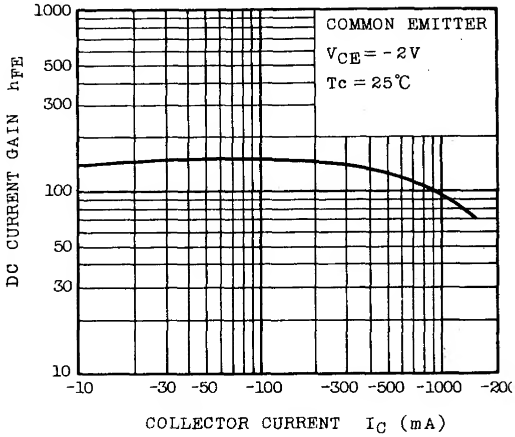
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55～150	°C

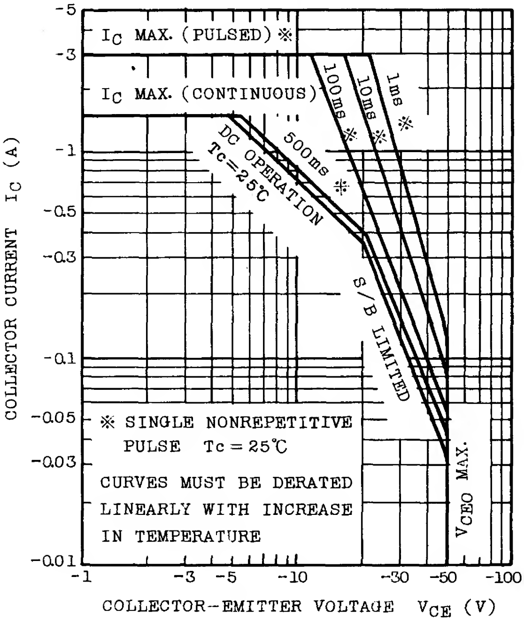
ELECTRICAL CHARACTERISTICS (Ta=25°C)

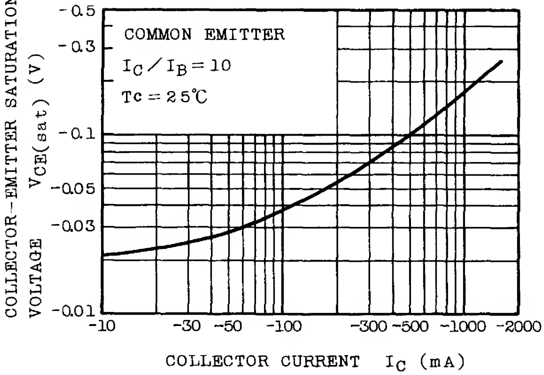
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	V_{CB}=-50V, I_E=0	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}=-5V, I_C=0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	I_C=-10mA, I_B=0	-50	-	-	V
DC Current Gain	h_{FE}	V_{CE}=-2V, I_C=-150mA	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=-1A, I_B=-0.1A	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	V_{CE}=-10V, I_C=-10mA	-0.50	-0.60	-0.70	V
Transition Frequency	f_T	V_{CE}=-10V, I_C=-100mA	50	100	-	MHz
Collector Output Capacitance	C_{ob}	V_{CB}=-10V, I_E=0, f=1MHz	-	30	-	pF


I_C – V_{CE}


h_{FE} – I_C

SAFE OPERATING AREA




$V_{CE(sat)}$ – I_C

S2000

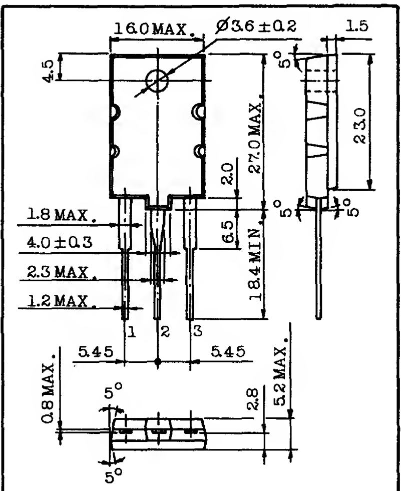
SILICON NPNTRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=5V (Max.)
- Fall Time : t_f=0.7μs (Typ.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-16D1A

Weight : 5.2g

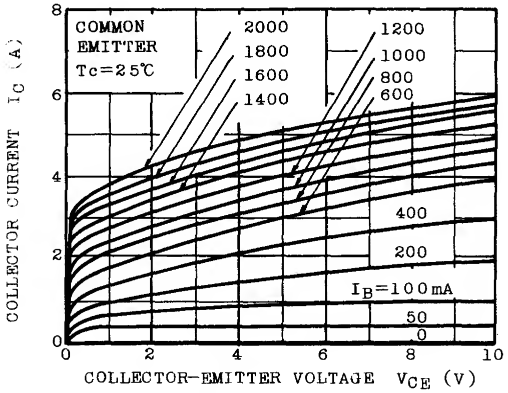
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-55～115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

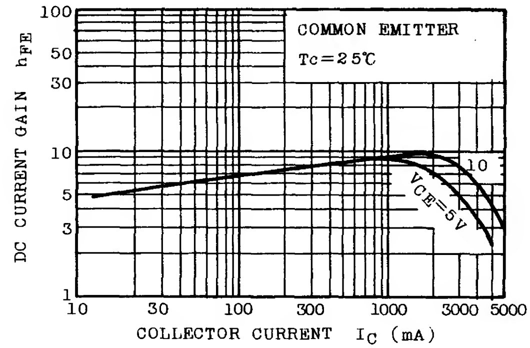
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4.5A, I_B=2A	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	-	-	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0, L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	125	-	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	0.7	-	μs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	10	-	μs

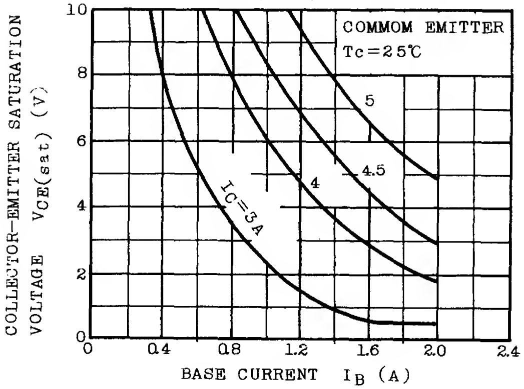
$I_C - V_{CE}$



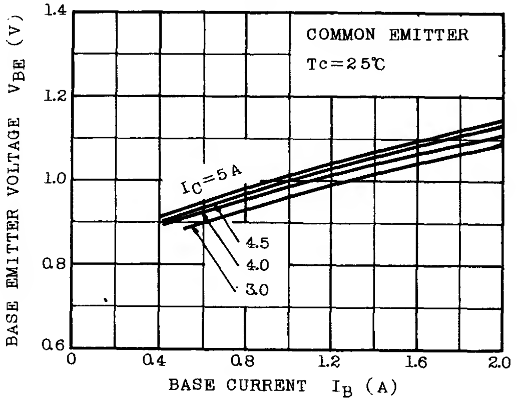
$h_{FE} - I_C$



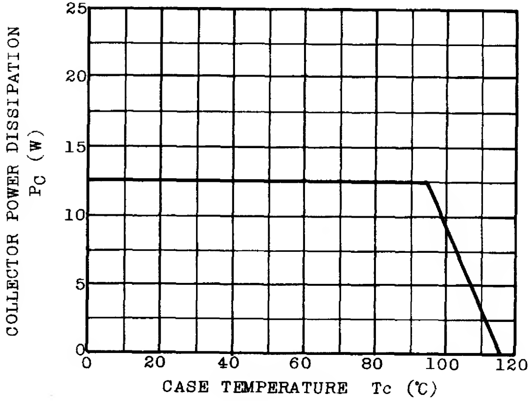
$V_{CE(sat)} - I_B$



$V_{BE} - I_B$



$P_C - Tc$



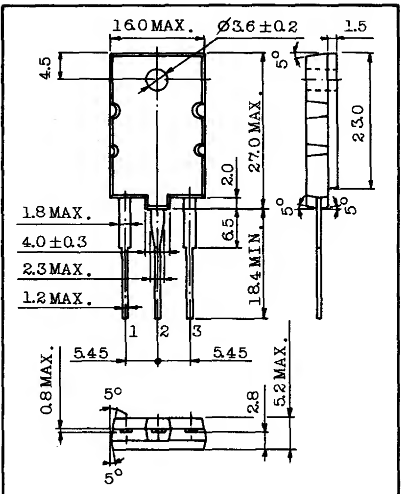
S2000A

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:
. High Voltage : V_{CES}=1500V
. Low Saturation Voltage : $V_{CE(sat)}$=1V (Max.)
. Fall Time : t_f=0.7μs (Typ.)
. Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

JEDEC	–
EIAJ	–
TOSHIBA	2–16D1A

Weight : 5.2g

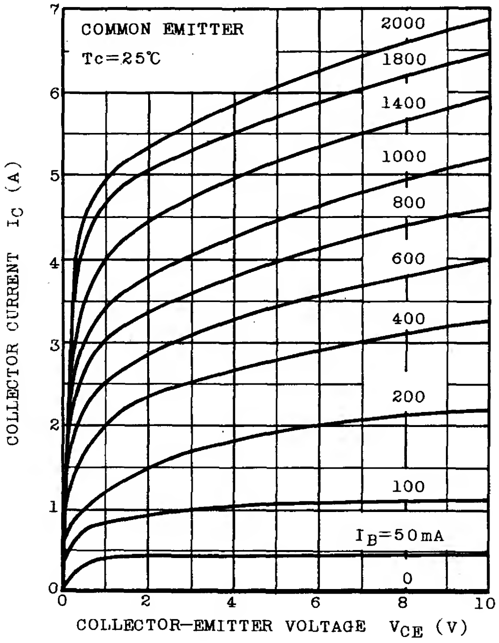
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-55~ +115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

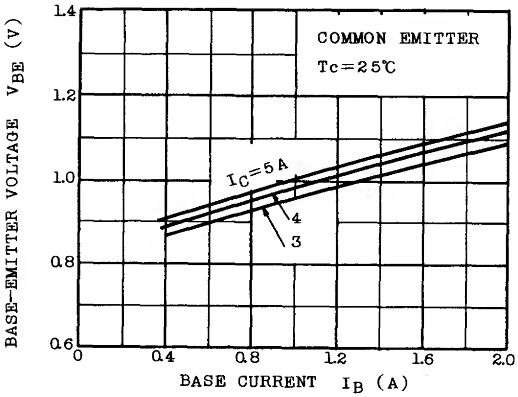
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	–	–	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=1mA, I_C=0	5	–	–	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=4.5A, I_B=2A	–	–	1	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	–	–	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0, L=25mH	700	–	–	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	–	7	–	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	–	125	–	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	–	0.7	–	μs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	–	10	–	μs

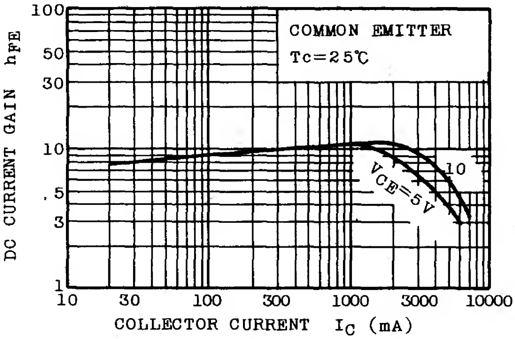
$I_C - V_{CE}$



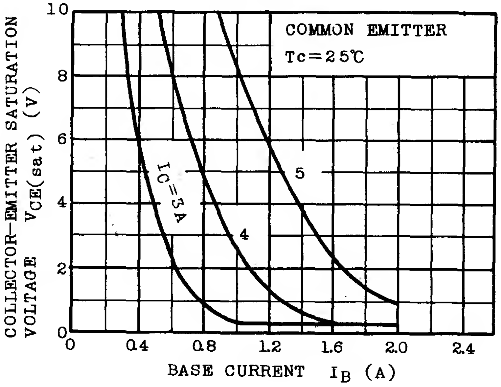
$V_{BE} - I_B$



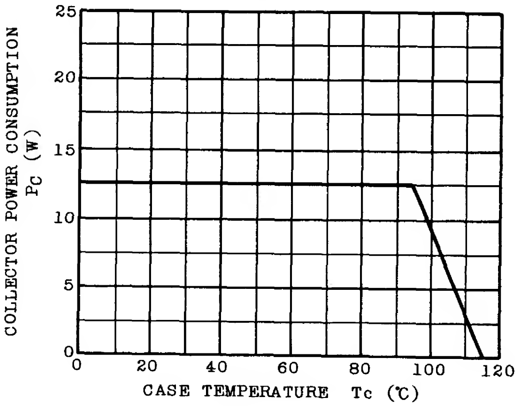
$h_{FE} - I_C$

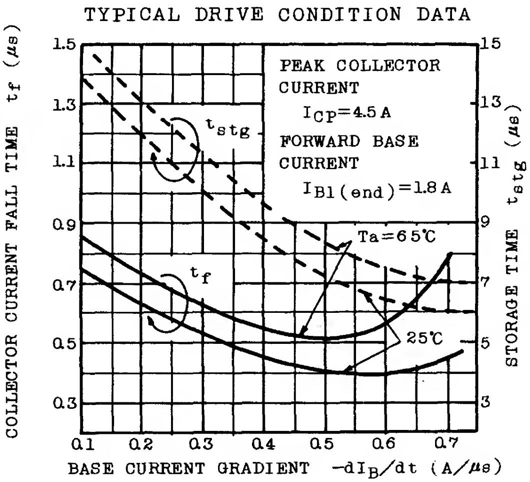


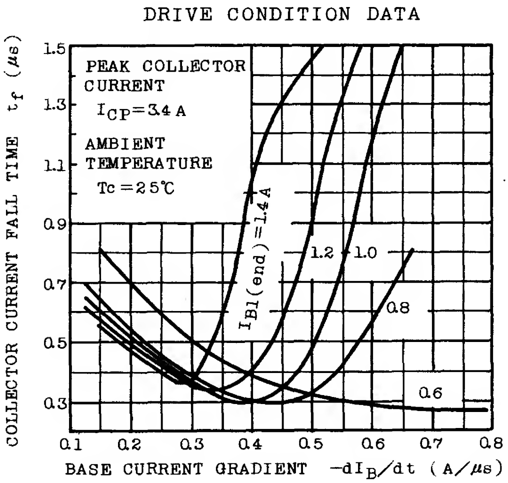
$V_{CE(sat)} - I_B$

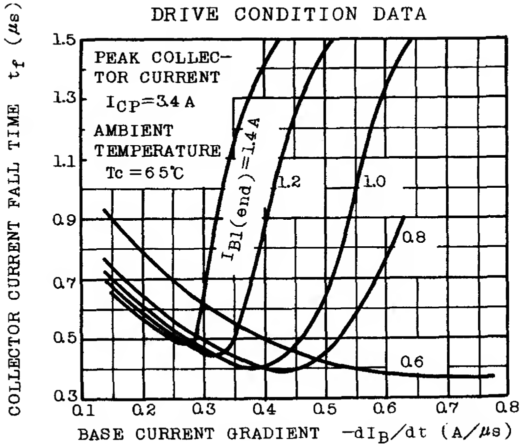


$P_C - Tc$




TYPICAL DRIVE CONDITION DATA
PEAK COLLECTOR CURRENT
I_{CP}=4.5 A
FORWARD BASE CURRENT
$I_{B1(end)}$=1.8 A
t_{stg}
t_f
Ta=65℃
25℃
COLLECTOR CURRENT FALL TIME t_f (μs)
STORAGE TIME t_{stg} (μs)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
15
13
11
9
7
5
3
0.1
0.2
0.3
0.4
0.5
0.6
0.7
BASE CURRENT GRADIENT $-dI_B/dt$ (A/μs)


DRIVE CONDITION DATA
PEAK COLLECTOR CURRENT
I_{CP}=3.4 A
AMBIENT TEMPERATURE
Tc=25℃
$I_{B1(end)}$=1.4 A
1.2
1.0
0.8
0.6
COLLECTOR CURRENT FALL TIME t_f (μs)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
BASE CURRENT GRADIENT $-dI_B/dt$ (A/μs)

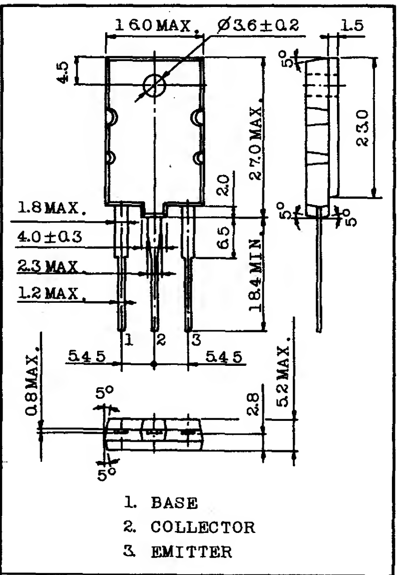

DRIVE CONDITION DATA
PEAK COLLECTOR CURRENT
I_{CP}=3.4 A
AMBIENT TEMPERATURE
Tc=65℃
$I_{B1(end)}$=1.4 A
1.2
1.0
0.8
0.6
COLLECTOR CURRENT FALL TIME t_f (μs)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
BASE CURRENT GRADIENT $-dI_B/dt$ (A/μs)

S2054

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2-16D1A

Weight : 5.2g

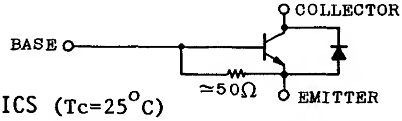
FEATURES:

- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=4V(Typ.)
- High Speed : t_f=0.7μs(Typ.)
- Built-in Damper Type.
- Glass Passivated Base-Collector Junction.

MAXIMUM RATINGS (Ta=25°C)

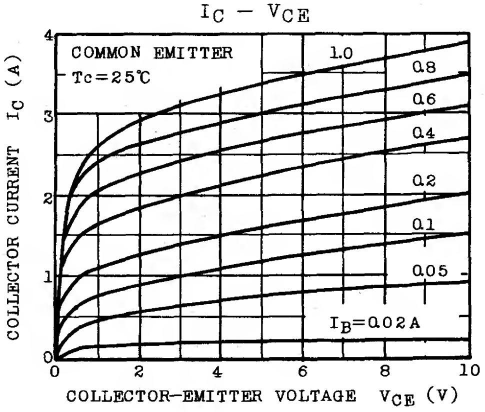
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	3.5	A
	Peak	I_{CM}	4	A
Base Current (Peak)		I_{BM}	2	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	10	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-65~115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

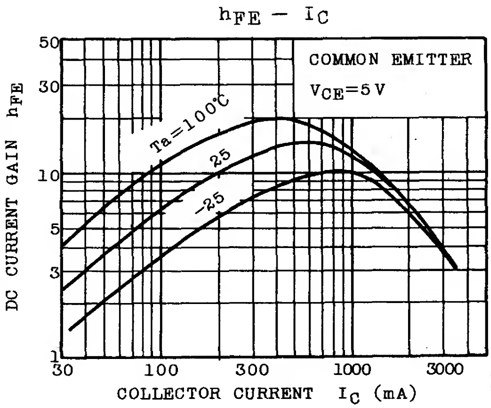
EQUIVALENT CIRCUIT

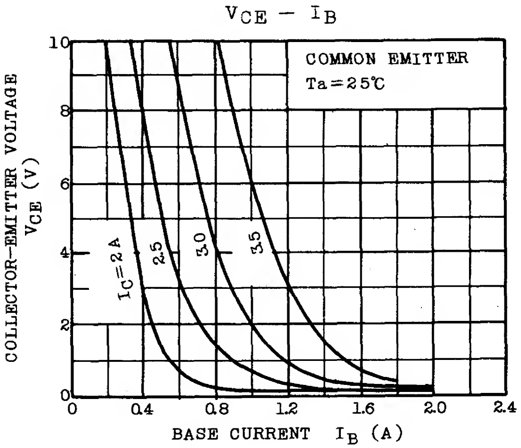


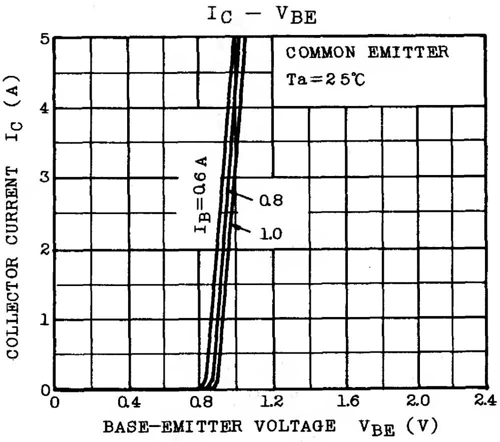
ELECTRICLAL CHARACTERISTICS (Tc=25°C)

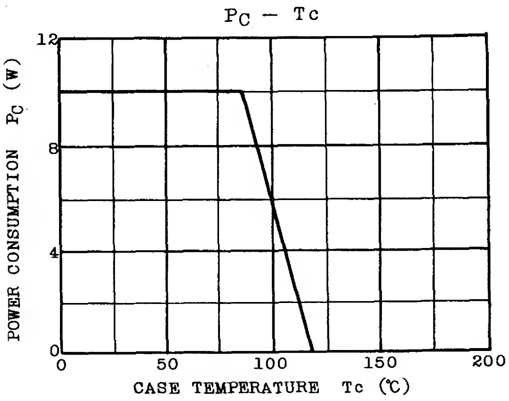
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{BE}=0, V_{CE}=1500V	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_C=0, I_E=200mA	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.5A	8	12	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.8A	-	4	8	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=3A, I_B=0.8A	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	I_F=3.5A	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CE(SUS)}$	I_B=0, I_C=100mA, L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, V_{IC}=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Switching Time	Fall Time	t_f	I_{CM}=3A, $I_{B(end)}$=0.8A	-	0.7	1.0	μs
	Storage Time	t_{stg}		-	7	-	


I_C — V_{CE}
COMMON EMITTER
Tc=25℃
1.0
0.8
0.6
0.4
0.2
0.1
0.05
I_B=0.02 A
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
0
2
4
6
8
10
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)


h_{FE} — I_C
COMMON EMITTER
V_{CE}=5 V
Ta=100℃
25
−25
DC CURRENT GAIN h_{FE}
1
3
5
10
30
50
30
100
300
1000
3000
COLLECTOR CURRENT I_C (mA)


V_{CE} — I_B
COMMON EMITTER
Ta=25℃
I_C=2 A
2.5
3.0
3.5
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
0
2
4
6
8
10
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE CURRENT I_B (A)


I_C — V_{BE}
COMMON EMITTER
Ta=25℃
I_B=0.6 A
0.8
1.0
COLLECTOR CURRENT I_C (A)
0
1
2
3
4
5
0
0.4
0.8
1.2
1.6
2.0
2.4
BASE-EMITTER VOLTAGE V_{BE} (V)


P_C — Tc
POWER CONSUMPTION P_C (W)
0
4
8
12
0
50
100
150
200
CASE TEMPERATURE Tc (℃)

SILICON NPN TRIPLE DIFFUSED MESA TYPE

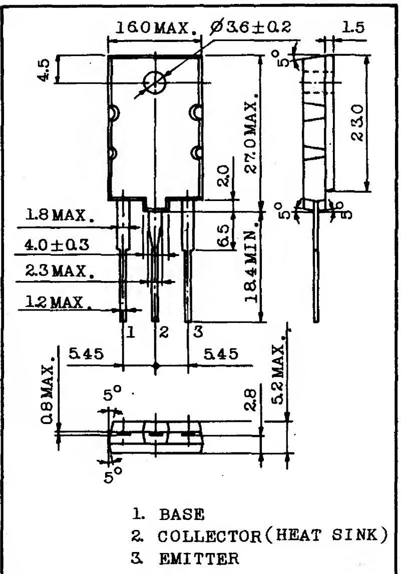
S2055
S2055A

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=1V(Max.) (S2055A)
- Fall Time : t_f=0.7μs (Typ.)
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

Unit in mm



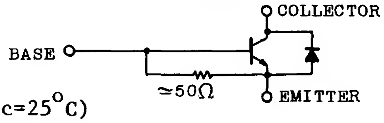
JEDEC	–
EIAJ	–
TOSHIBA	2–16D1A

Weight : 5.2g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (T_c≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-65~115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	-	-	
Collector-Emitter Saturation Voltage	S2055	$V_{CE(sat)}$	I_C=4.5A, I_B=2A	-	-	5	V
	S2055A			-	-	1	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	I_F=5A	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CE(SUS)}$	I_C=100mA, I_B=0 L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	125	-	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	0.7	-	μs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	10	-	μs

S2056

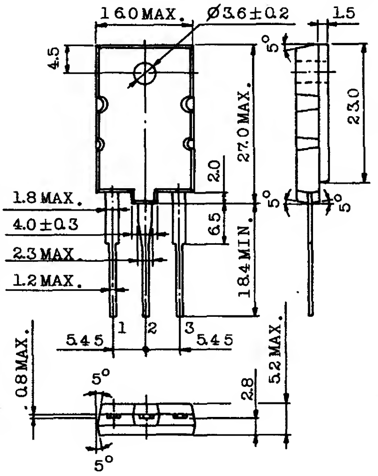
SILICON NPN TRIPLE DIFFUSED MESA TYPE

TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : V_{CES}=1500V
- High Speed : t_f=0.75µs (Typ.)
- Glass Passivated Collector-Base Junction

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

JEDEC	―
EIAJ	―
TOSHIBA	2-16D1A

Weight : 5.2g

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage (V_{BE}=0V)		V_{CES}	1500	V
Collector-Emitter Voltage (R_{BE}=100Ω)		V_{CER}	1500	V
Transient Collector-Emitter Voltage (Flash-over)		V_{CE} (Flash-over)	1650	V
Collector-Emitter Voltage (Open Base)		V_{CEO}	700	V
Collector Current	DC	I_C	2.5	A
	Peak	I_{CM}	3	
Transient Collector Current (Flash-over)		I_C (Flash-over)	5	A
Base Current (Peak)		I_{BM}	2.5	A
Reverse Base Current	DC	$-I_B$	100	mA
	Peak	$-I_{BM}$	1.5	A
Collector Power Dissipation (T_c≦90°C)		P_C	10	W
Junction Temperature		T_j	115	°C
Storage Temperature Range		T_{stg}	-65~115	°C

ELECTRICAL CHARACTERISTICS (T_a=25°C)

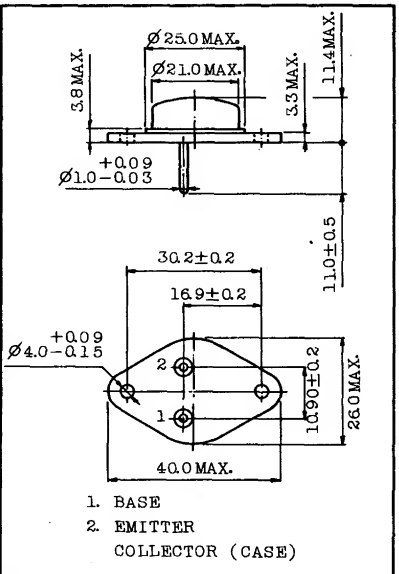
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	V_{BE}=0, V_{CE}=V_{CES}	-	-	1	mA
DC Current Gain	h_{FE}	V_{CE}=5V, I_C=2A	2	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	I_E=100mA	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C=2A, I_B=1A	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C=2A, I_B=1A	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	I_C=100mA, L=25mH	700	-	-	V
Fall Time	t_f	I_{CP}=2A, $I_{B(end)}$=1A	-	0.75	-	µs
Collector Output Capacitance	C_{ob}	V_{CB}=10V, f=1MHz	-	95	-	pF
Transition Frequency	f_T	V_{CE}=5V, f=5MHz, I_C=0.1A	-	3	-	MHz

SILICON NPN TRIPLE DIFFUSED MESA TYPE

S2818
S2818A

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

Unit in mm



JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

Mounting Kit No. AC42C

Weight : 17.0g

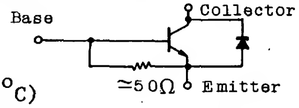
FEATURES:
- High Voltage : V_{CES}=1500V
- Low Saturation Voltage : $V_{CE(sat)}$=1V (Max.)(S2818A)
- High Speed : t_f=0.7μs (Typ.)

- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		T_{stg}	-65~115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=4.5A	2.25	-	-	
Collector-Emitter Saturation Voltage	S2818	$V_{CE(sat)}$	I_C=4.5A, I_B=2A	-	-	5	V
	S2818A			-	-	1	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=4.5A, I_B=2A	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	I_F=5A	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0, L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	125	-	pF
Switching Time	Fall Time	t_f	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	0.7	-	μs
	Storage Time	t_{stg}	I_{CM}=4.5A, $I_{B(end)}$=1.8A	-	10	-	μs

S2824

SILICON NPN TRIPLE DIFFUSED MESA TYPE

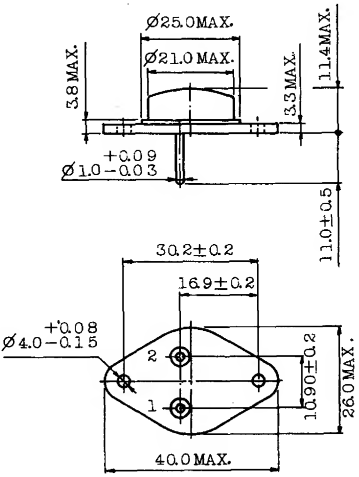
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

. High Voltage	: V_{CES}=1500V
. Low Saturation Voltage	: $V_{CE(sat)}$=5V(Max.)
. High Speed	: t_f=0.7µs (Typ.)

. Built-in Damper Type.
. Glass Passivated Collector-Base Junction.

Unit in mm



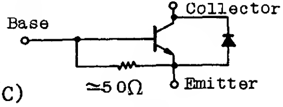
1. BASE
2. EMITTER
COLLECTOR (CASE)

JEDEC	TO-3
EIAJ	TC-3, TB-3
TOSHIBA	2-21B1A

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	2.5	A
	Peak	I_{CM}	3	A
Base Current (Peak)		I_{BM}	2.5	A
Total Power Dissipation (Tc≦95°C)		P_{tot}	10	W
Junction Temperature		T_j	+115	°C
Storage Temperature Range		Tstg	-65～115	°C
Thermal Resistance		$R_{th(j-c)}$	1.6	°C/W

EQUIVALENT CIRCUIT

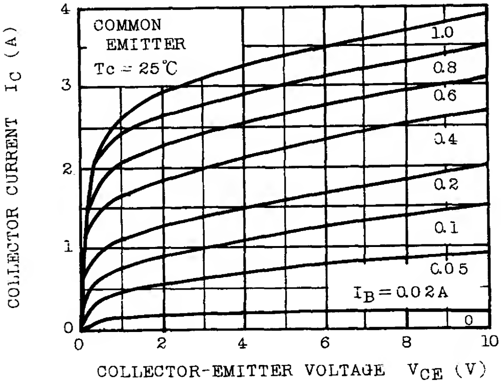


Mounting Kit No. AC42C
Weight : 17.0g

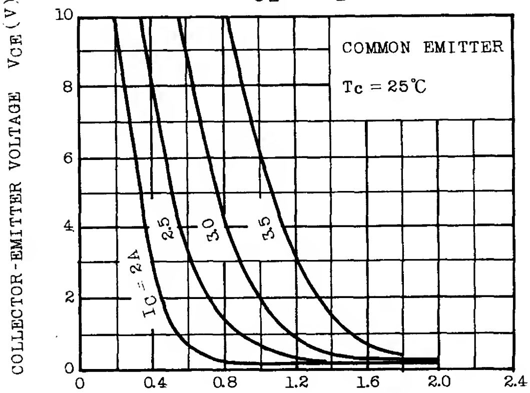
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	V_{CE}=1500V, V_{BE}=0	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	I_E=200mA, I_C=0	5	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=2A	2	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=2A, I_B=1A	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	I_C=2A, I_B=1A	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	I_F=3.5A	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=100mA, I_B=0, L=25mH	700	-	-	V
Transition Frequency		f_T	V_{CE}=5V, I_C=0.1A	-	7	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	95	-	pF
Switching Time	Fall Time	t_f	I_{CM}=2A, $I_{B(end)}$=1A	-	0.7	1.0	µs
	Storage Time	t_{stg}	I_{CM}=2A, $I_{B(end)}$=1A	-	7	-	µs

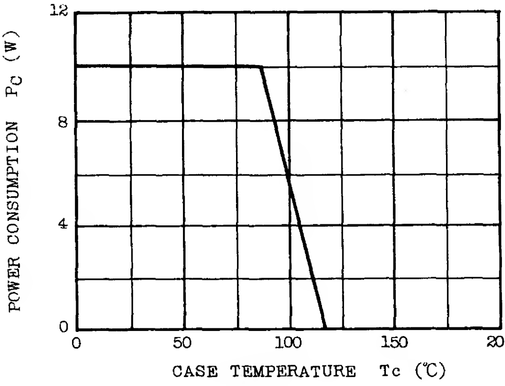
$I_C - V_{CE}$



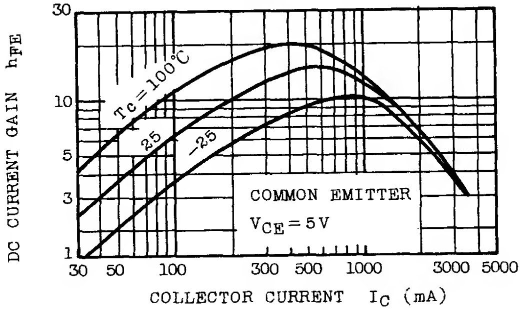
$V_{CE} - I_B$



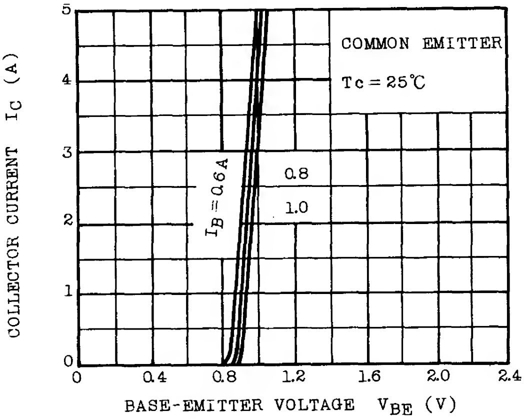
$P_C - T_c$



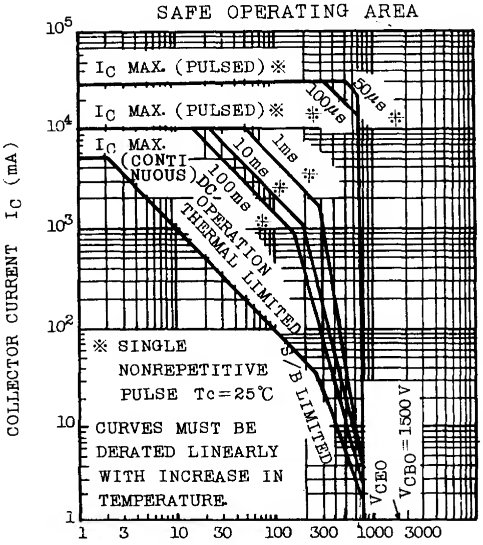
$h_{FE} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA



※ SINGLE NONREPETITIVE PULSE Tc=25℃

CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE.

S-AU
SERIES

TOSHIBA RF POWER AMPLIFIER MODULE

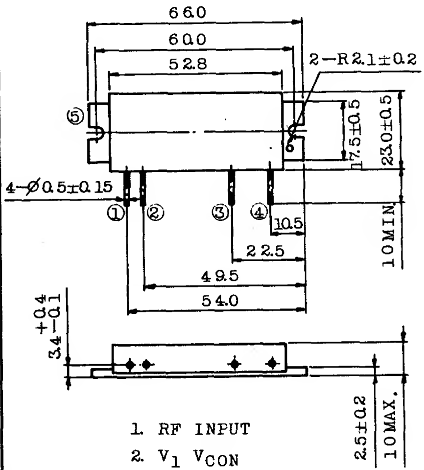
S-AU3

UHF POWER AMPLIFIER MODULE (HAM FM)

FEATURES:

- Output Power : $P_O \gtrsim 15W$
- Minimum Gain : $G_p=18.7dB$
- Efficiency : $\eta_T \gtrsim 40\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53C

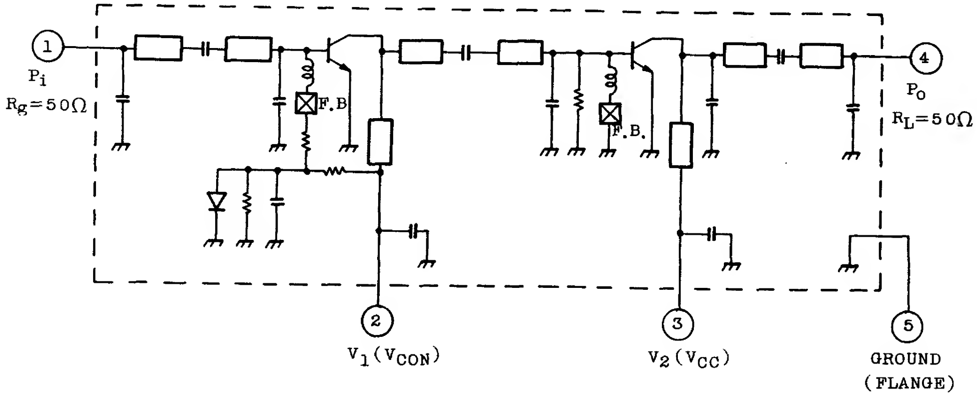
MAXIMUM RATINGS ($Tc=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	−30 ~ 100	°C
Storage Temperature Range	Tstg	−40 ~ 110	°C

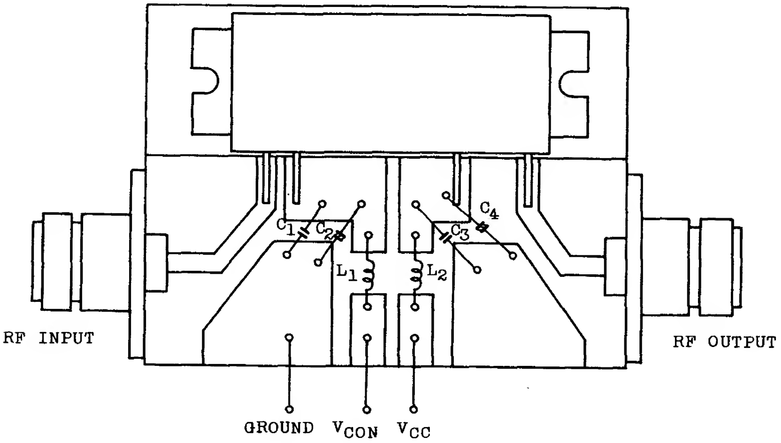
CHARACTERISTICS ($Tc=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	430	-	450	MHz
Output Power	P_O	$P_i=200mW$ $V_{CC}=12.5V$, $V_{CON}=12.5V$ $Zg=Z_l=50\Omega$	15	17	-	W
Power Gain	Gp		18.7	19.2	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	$V_{CC}=15V$, $V_{CON}=12.5V$ $P_i=200mW$ VSWR load 20:1 all phase	No Degradation			-
Stability	-	$V_{CC}=12.5V$, $P_i=200mW$ $V_{CON}=0 \sim 12.5V$ VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

SCHEMATIC



TEST MOUNT

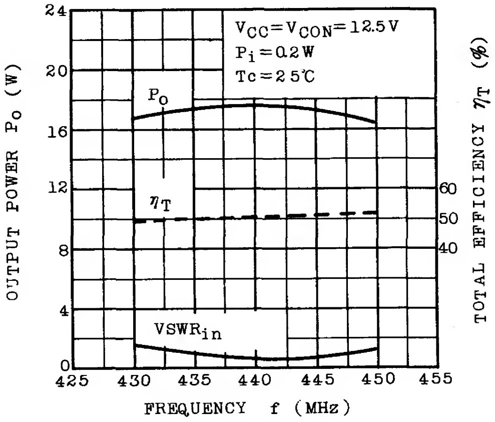


C_1, C_3 : 15000pF

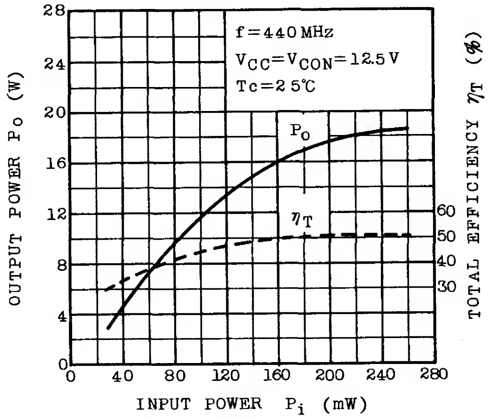
C_2, C_4 : 1μF

L_1, L_2 : Ø0.8 COPPER WIRE 8T, 5ID

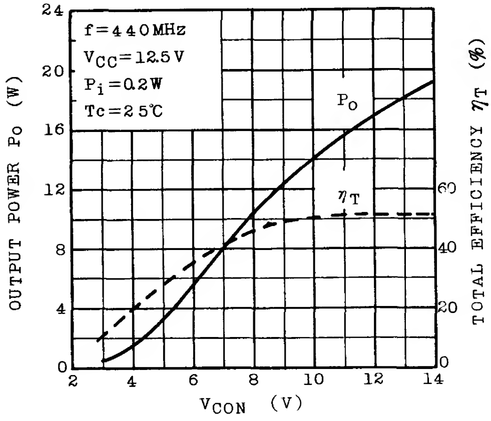
P_O, η_T, $VSWR_{in}$ − f



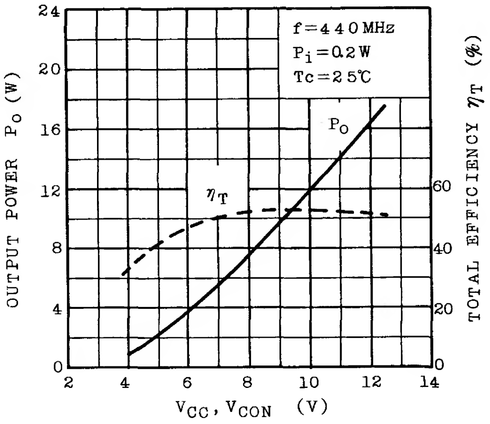
P_O, η_T − P_i



P_O, η_T − V_{CON}



P_O, η_T − V_{CC}, V_{CON}

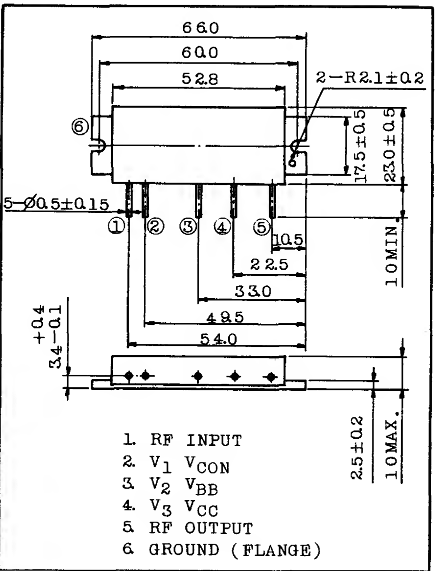


S-AU4

TOSHIBA RF POWER AMPLIFIER MODULE

UHF POWER AMPLIFIER MODULE (HAM SSB/FM)

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{BB}
4. V_3 V_{CC}
5. RF OUTPUT
6. GROUND (FLANGE)

JEDEC	―
EIAJ	―
TOSHIBA	5−53B

FEATURES:

- Output Power : $P_o \geqq 17W$
- Minimum Gain : Gp=19.2dB
- Efficiency : $\eta_T \geqq 35\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

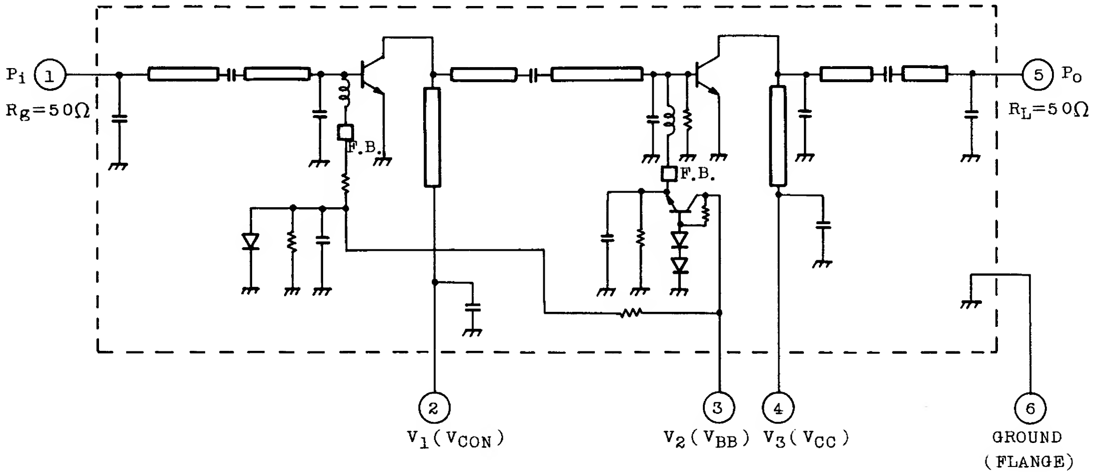
MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30～100	°C
Storage Temperature Range	T_{stg}	-40～110	°C

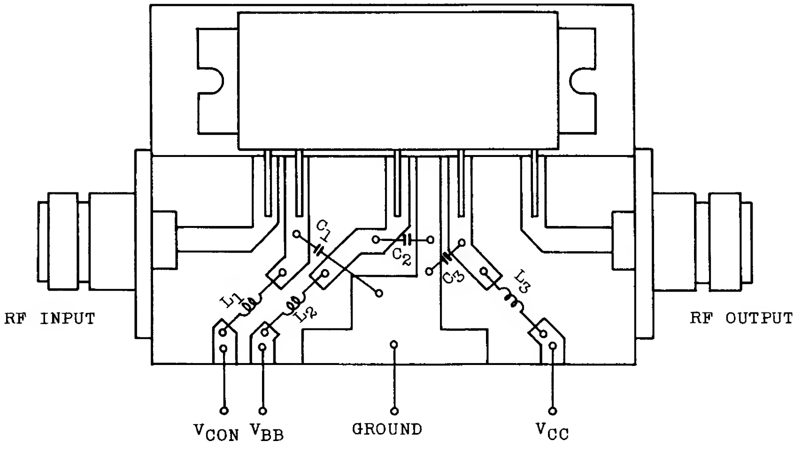
CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	430	-	450	MHz
Output Power	P_o	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V Z_g=Z_l=50Ω	17	20	-	W
Power Gain	Gp		19.2	20	-	dB
Total Efficiency	η_T		35	45	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_o=20W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0～12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-
Intermodulation Distortion Ratio	IMD	f_1=440.000MHz, f_2=440.002MHz V_{CC}=V_{CON}=12.5V, V_{BB}=9V P_o=13W_{PEP}	-	-32	-	dB

SCHEMATIC



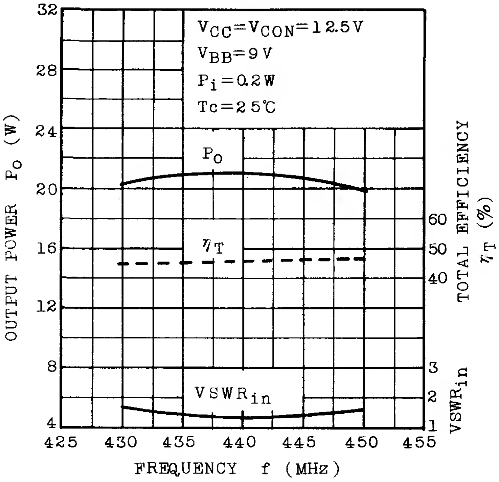
TEST MOUNT



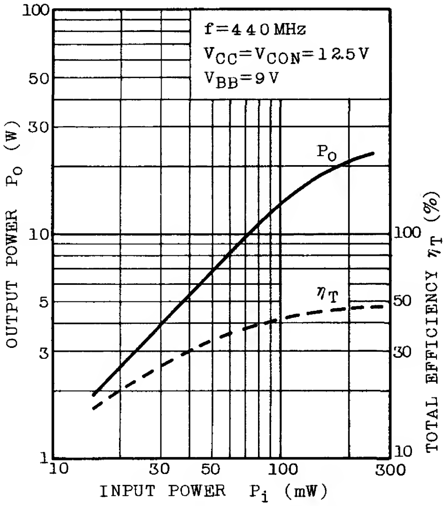
C_1, C_2, C_3 : 1500pF, 10μF

L_1, L_2, L_3 : Ø0.8 COPPER WIRE , 8T, 5ID

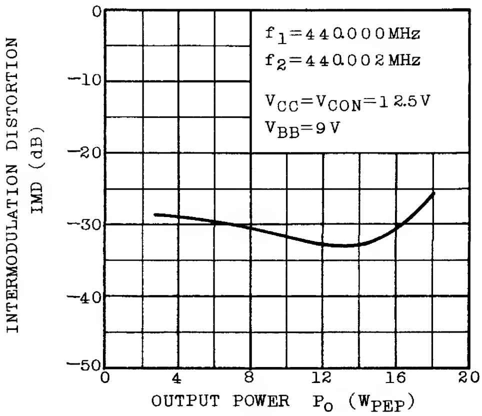
P_O, η_T, $VSWR_{in}$ – f



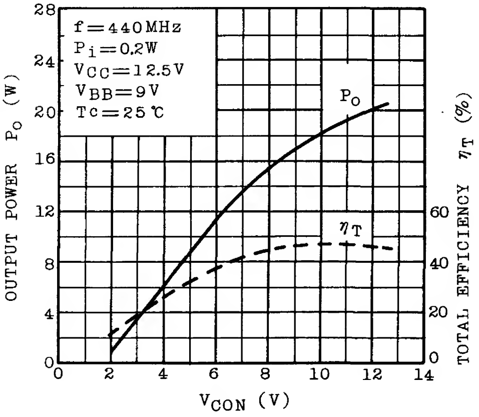
P_O, η_T – P_i



IMD – P_O



P_O, η_T – V_{CON}



TOSHIBA RF POWER AMPLIFIER MODULE

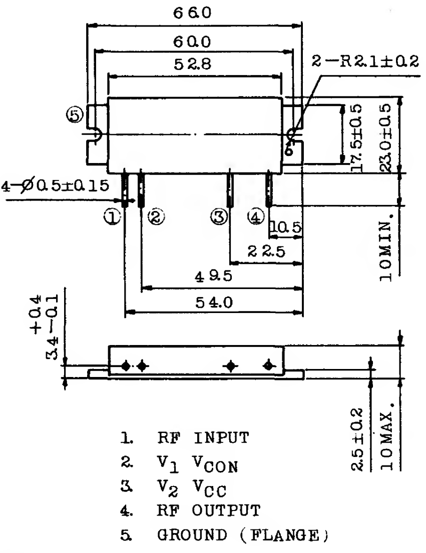
S-AU5L
S-AU5M
S-AU5H

UHF POWER AMPLIFIER MODULE

FEATURES:

- Output Power : $P_O \geqq 7W$
- Minimum Gain : $G_p = 15.4dB$
- Efficiency : $\eta_T \geqq 40\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53C

MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30 ~ 100	°C
Storage Temperature Range	T_{stg}	-40 ~ 110	°C

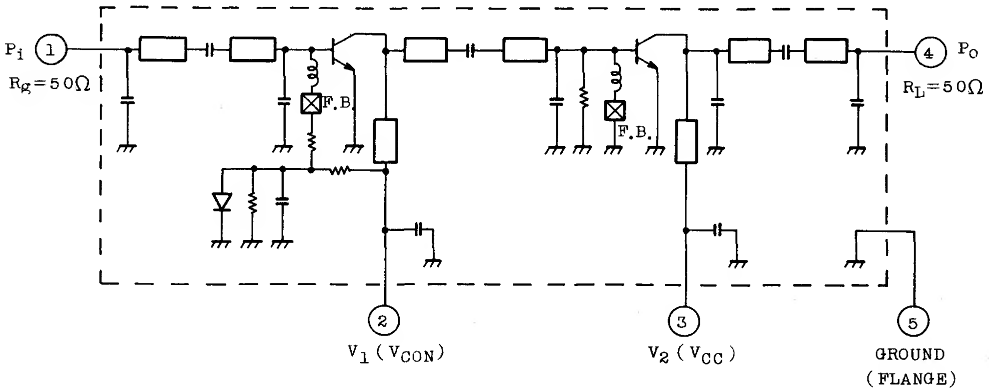
CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f_{range}	-	400	-	512	MHz
Output Power	P_O	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V $Z_g=Z_l=50\Omega$	7	-	-	W
Power Gain	Gp		15.4	-	-	dB
Total Efficiency	η_T		40	48	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_i=200mW VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

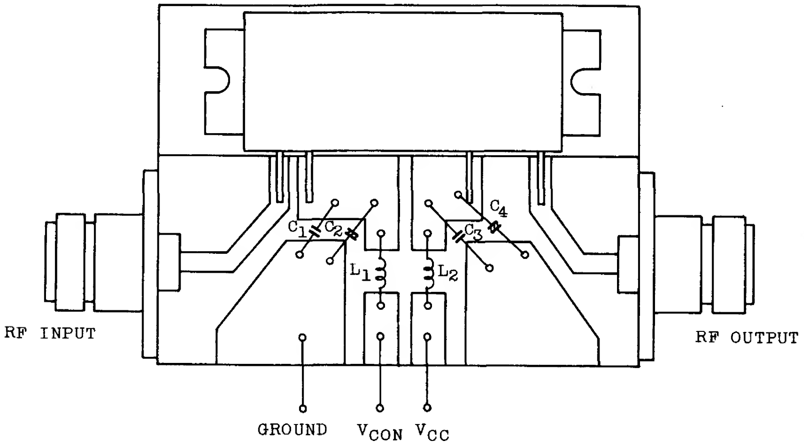
(1) Frequency range is covered in three bands

S-AU5L	400-440MHz
S-AU5M	440-480MHz
S-AU5H	480-512MHz

SCHEMATIC



TEST MOUNT

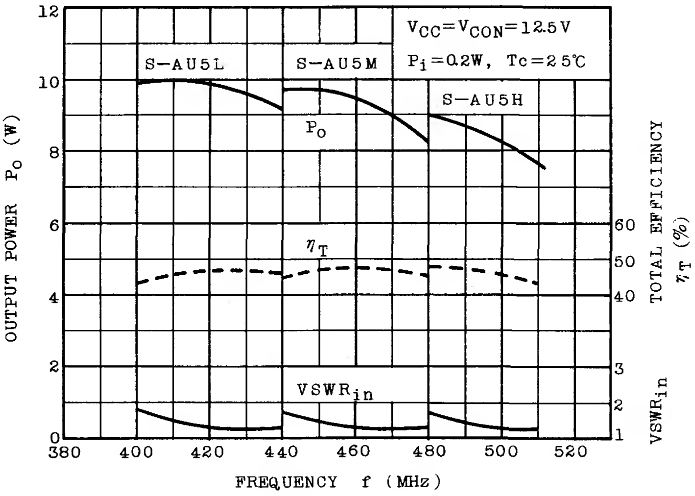


C_1, C_3 : 15000pF

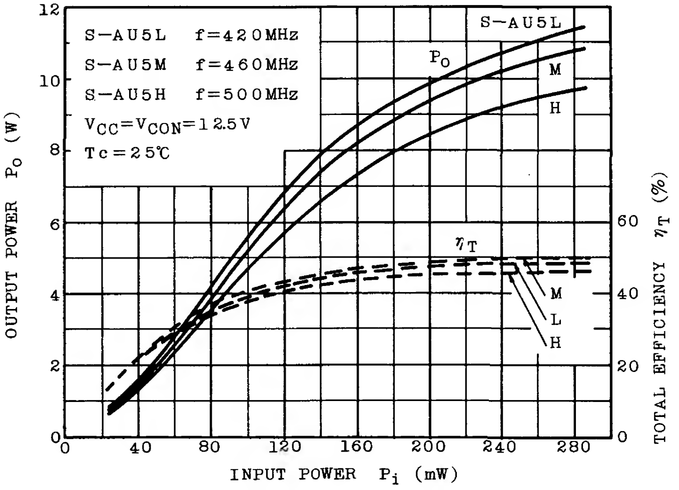
C_2, C_4 : 1μF

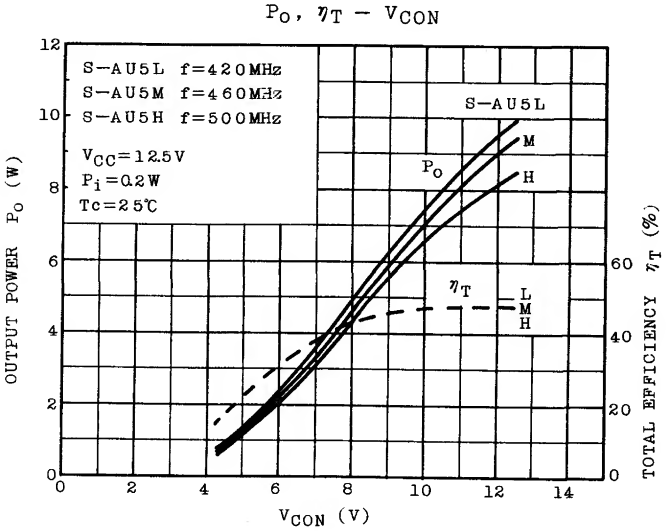
L_1, L_2 : ∅0.8 COPPER WIRE 8T, 5ID

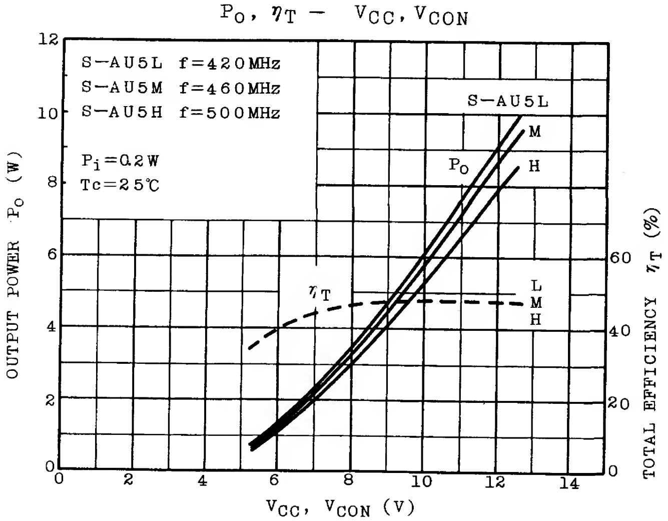
P_O, η_T, $VSWR_{in}$ – f



P_O, η_T – P_i




Po, ηT − VCON
S−AU5L f=420MHz
S−AU5M f=460MHz
S−AU5H f=500MHz
VCC=12.5V
Pi=0.2W
Tc=25℃
S−AU5L
M
H
Po
ηT
L
M
H
OUTPUT POWER Po (W)
TOTAL EFFICIENCY ηT (%)
VCON (V)
0
2
4
6
8
10
12
14
0
20
40
60

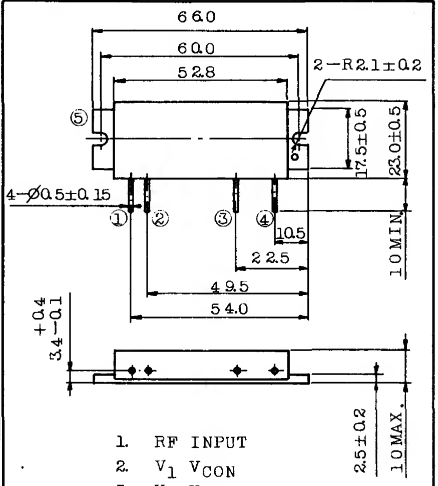

Po, ηT − VCC, VCON
S−AU5L f=420MHz
S−AU5M f=460MHz
S−AU5H f=500MHz
Pi=0.2W
Tc=25℃
S−AU5L
M
H
Po
ηT
L
M
H
OUTPUT POWER Po (W)
TOTAL EFFICIENCY ηT (%)
VCC, VCON (V)
0
2
4
6
8
10
12
14
0
20
40
60

TOSHIBA RF POWER AMPLIFIER MODULE

S-AU6L
S-AU6M
S-AU6H

UHF POWER AMPLIFIER MODULE

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	−
EIAJ	−
TOSHIBA	5−53C

FEATURES:

- Output Power : $P_o \geqq 13W$
- Minimum Gain : Gp=18.1dB
- Efficiency : $\eta_T \geqq 40\%$
- 50Ω Input/ Output Impedance
- Guaranteed Stability

MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30 ~ 100	°C
Storage Temperature Range	Tstg	-40 ~ 110	°C

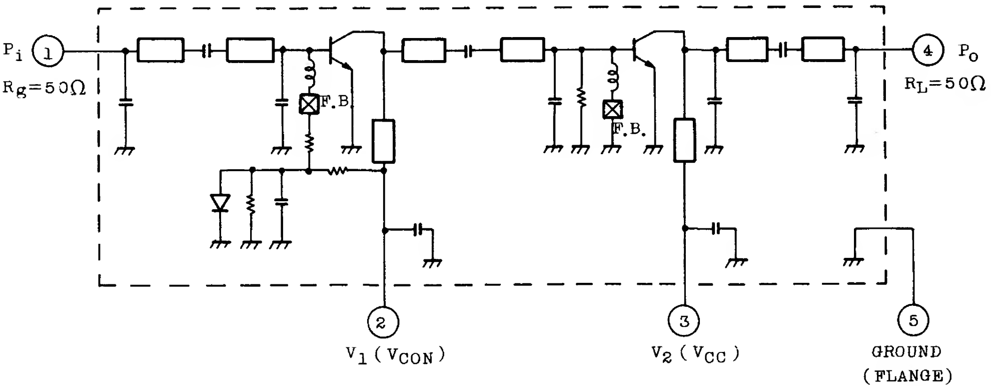
CHARACTERISTICS (Tc=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f_{range}	-	400	-	512	MHz
Output Power	P_o	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V Z_g=Z_l=50Ω	13	-	-	W
Power Gain	Gp		18.1	-	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	VSWRin		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_i=200mW VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

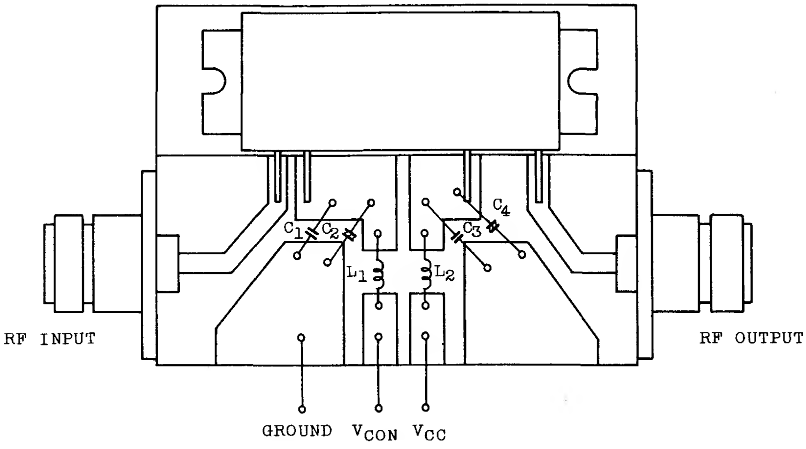
(1) Frequency range is covered in three bands

S-AU6L	400-440MHz
S-AU6M	440-480MHz
S-AU6H	480-512MHz

SCHEMATIC



TEST MOUNT

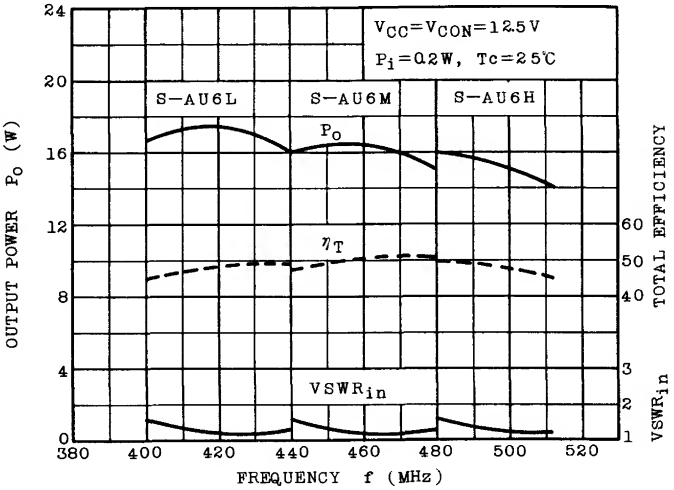


C_1, C_3 : 15000pF

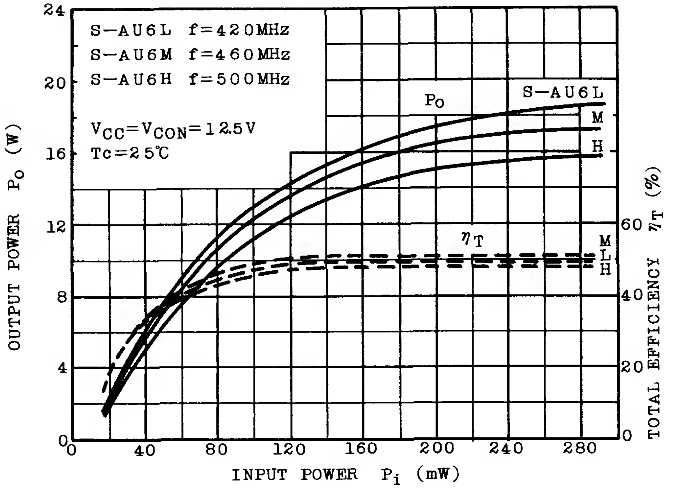
C_2, C_4 : 1μF

L_1, L_2 : ⌀0.8 COPPER WIRE 8T, 5ID

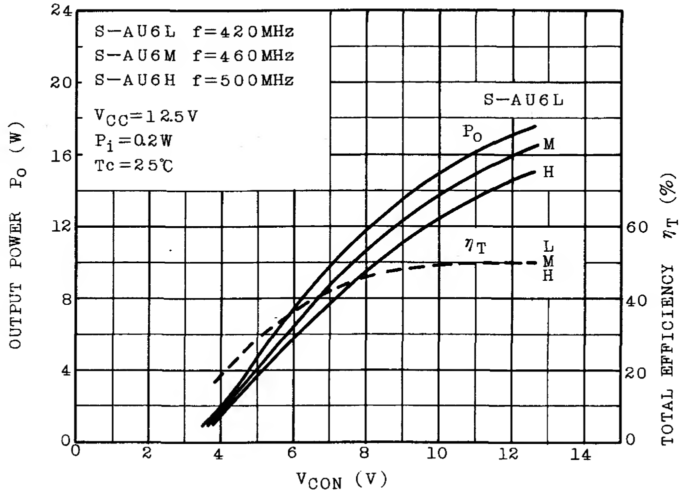
P_o, η_T, $VSWR_{in}$ – f



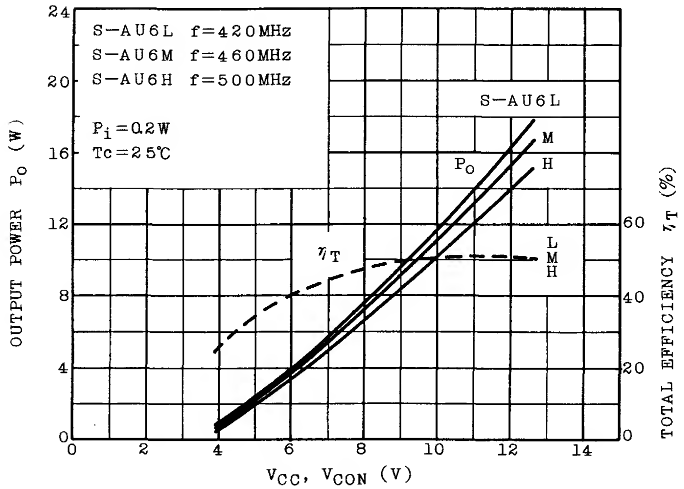
P_o, η_T – P_i



P_O, η_T – V_{CON}



P_O, η_T – V_{CC}, V_{CON}



TOSHIBA RF POWER AMPLIFIER MODULE

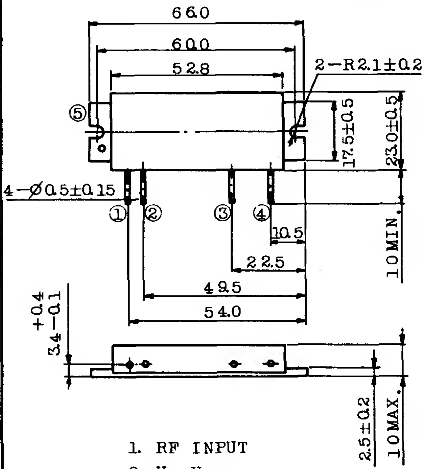
S-AU7

800MHz UHF POWER AMPLIFIER MODULE (FM)

FEATURES:

- Output Power : $P_O \geqq 15$W
- Minimum Gain : Gp=18.7dB
- Efficiency : $\eta_T \geqq 30\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	−
EIAJ	−
TOSHIBA	5−53

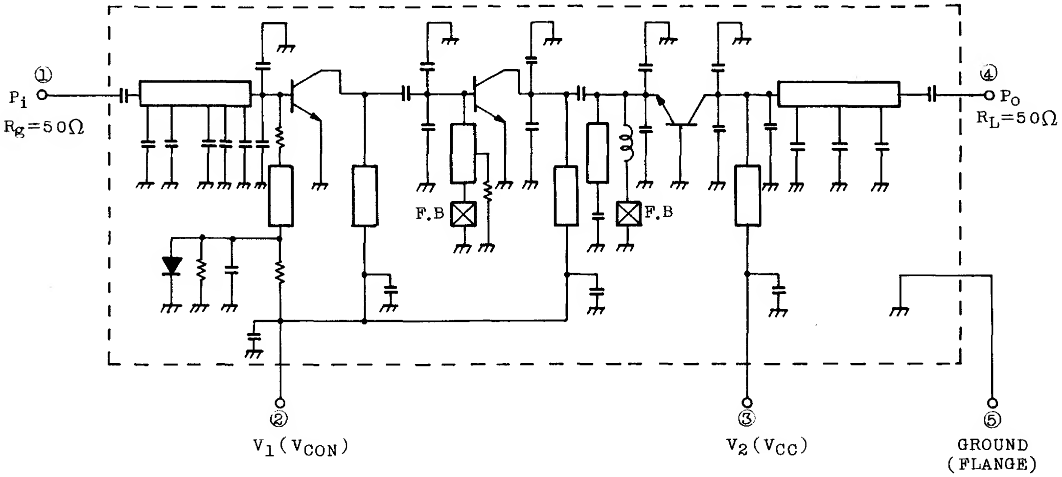
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	15	V
DC Supply Voltage	V_{CON}	15	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	−30 ~ 100	°C
Storage Temperature Range	Tstg	−40 ~ 110	°C

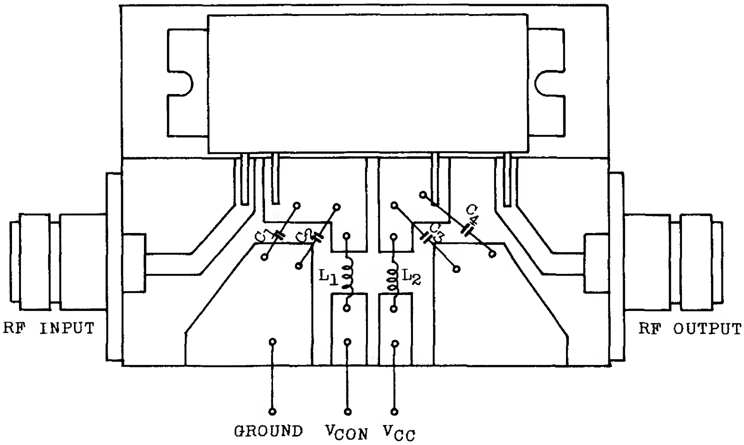
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	806	-	825	MHz
Output Power	P_i	P_O=15W V_{CC}=12.5V, V_{CON}=1.25V Z_g=Z_l=50Ω	-	80	200	mW
Power Gain	Gp		18.7	22.7	-	dB
Total Efficiency	η_T		30	35	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2.5	-
Harmonics	HRM		-	−30	−25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=15V P_O=18W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=100 to 200mW V_{CON}=0 ~ 15V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

SCHEMATIC



TEST MOUNT

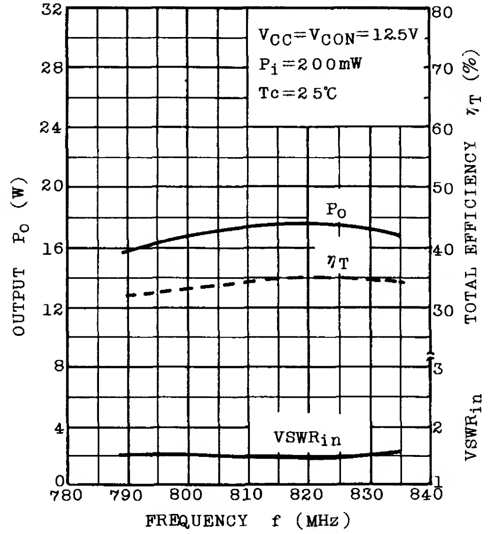


C_1, C_3 : 1500pF

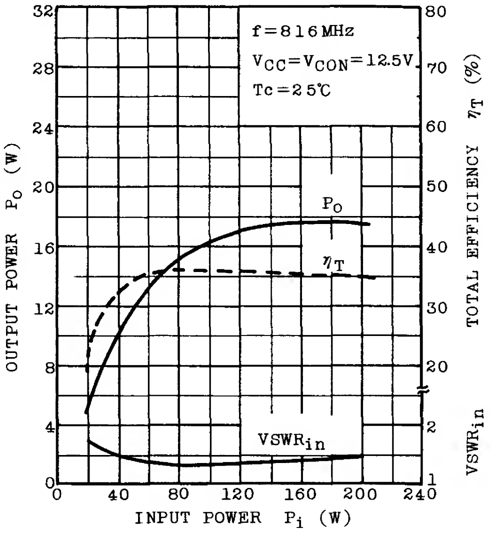
C_2, C_4 : 1μF

L_1, L_2 : ∅0.8 Ag PLATED WIRE, 8T 5ID

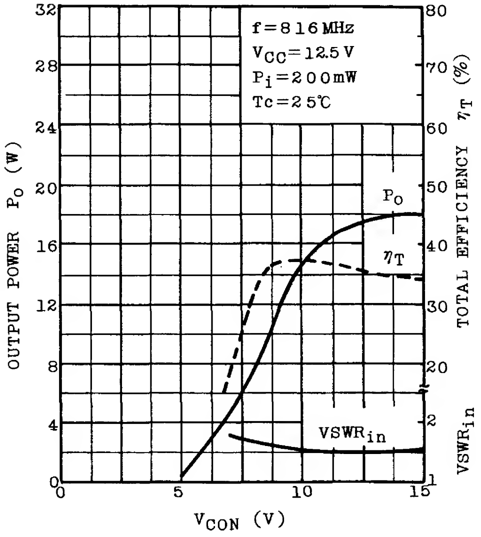
P_o, η_T, $VSWR_{in}$ — f



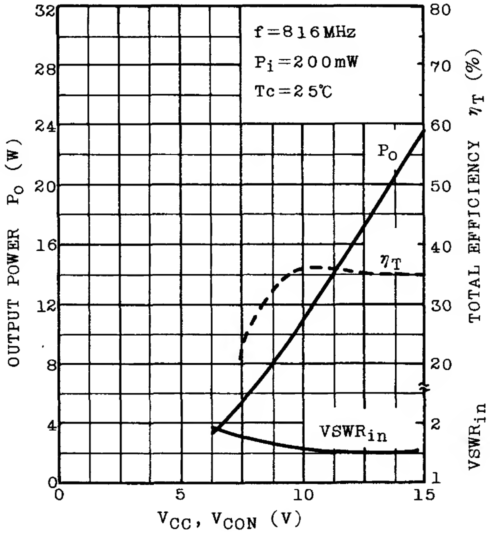
P_o, η_T, $VSWR_{in}$ — P_i



P_o, η_T, $VSWR_{in}$ — V_{CON}



P_o, η_T, $VSWR_{in}$ — V_{CC}, V_{CON}



S-AV

SERIES

TOSHIBA RF POWER AMPLIFIER MODULE

S-AV5

VHF POWER AMPLIFIER MODULE (HAM FM)

FEATURES:

. Output Power : $P_O \geqq 15W$

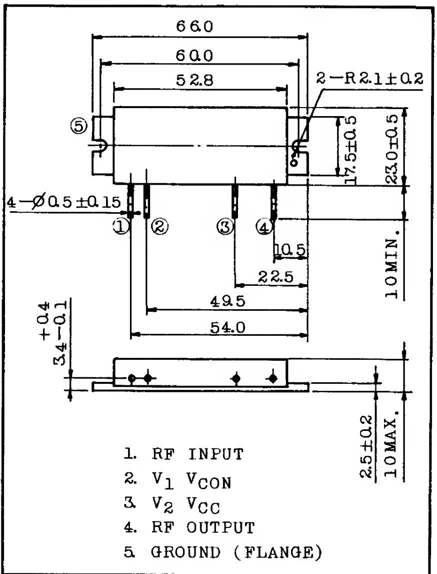
. Minimum Gain : $G_P \geqq 18.7dB$

. Efficiency : $\eta_T \geqq 48\%$

. 50Ω Input/Output Impedance

. Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

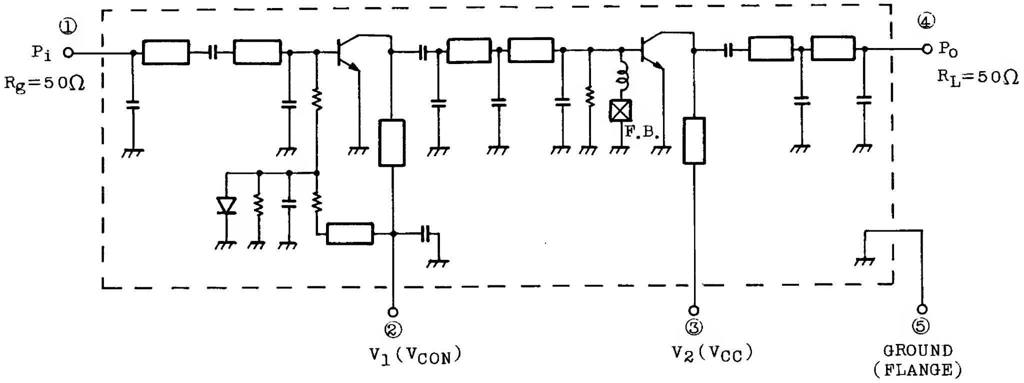
JEDEC	—
EIAJ	—
TOSHIBA	5−53C

MAXIMUM RATINGS ($T_c=25^\circ C$)

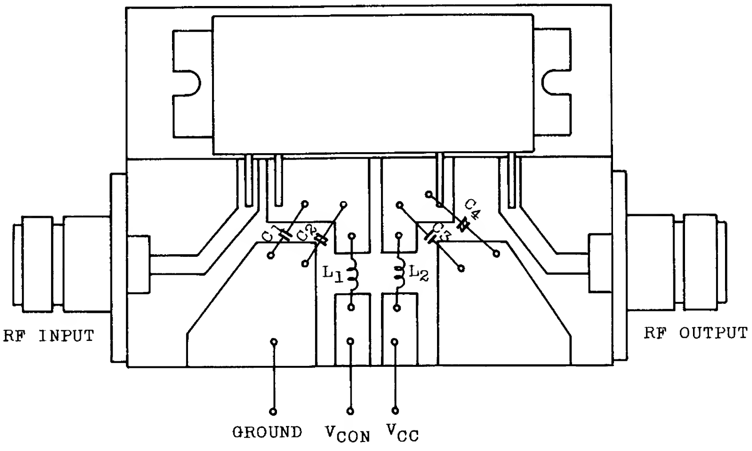
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30 ~ 100	°C
Storage Temperature Range	T_{stg}	-40 ~ 110	°C

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_o	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V $Z_g=Z_l=50\Omega$	15	20	-	W
Power Gain	G_P		18.7	20	-	dB
Total Efficiency	η_T		48	53	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_o=18W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~12.5V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

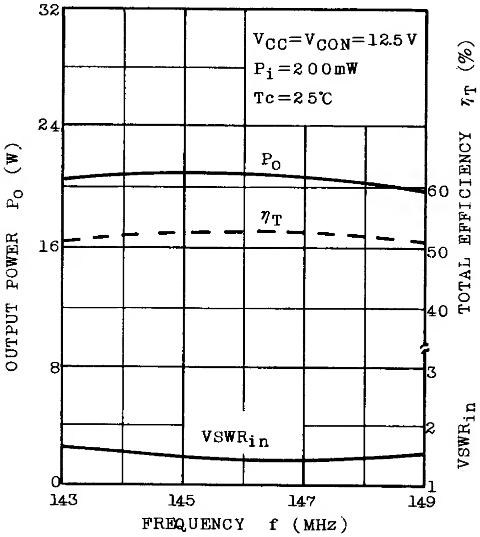
SCHEMATIC

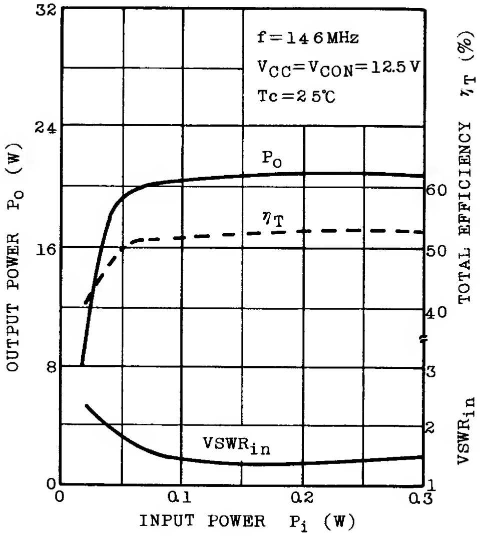


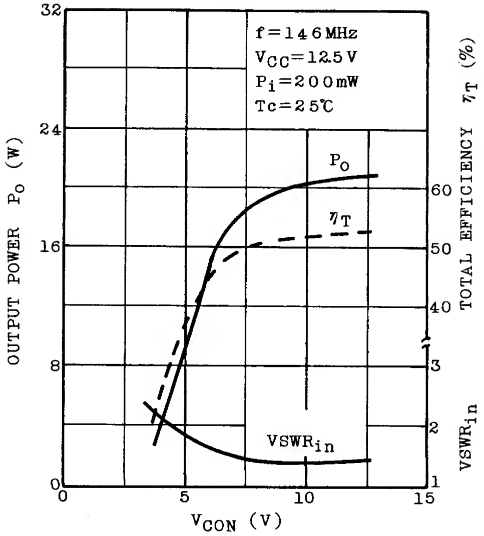
TEST MOUNT

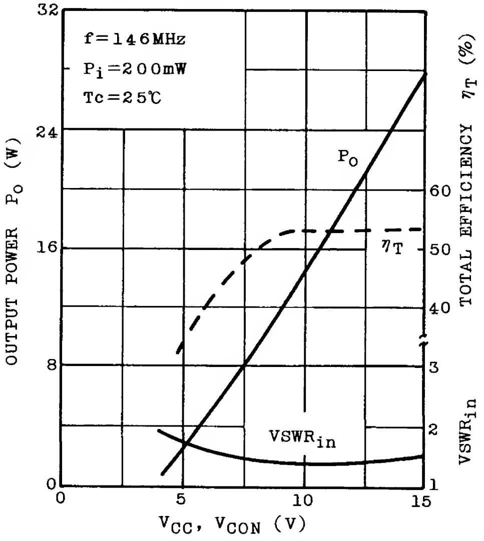


C_1, C_3 : 15000pF
C_2, C_4 : 1 μF
L_1, L_2 : ∅0.8 A_g PLATED WIRE, 8T, 5ID


P_o, η_T, $VSWR_{in}$ − f


P_o, η_T, $VSWR_{in}$ − P_{in}


P_o, η_T, $VSWR_{in}$ − V_{CON}


P_o, η_T, $VSWR_{in}$ − V_{CC}, V_{CON}

S-AV6

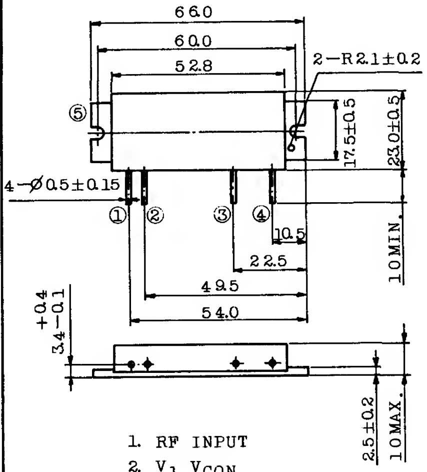
TOSHIBA RF POWER AMPLIFIER MODULE

VHF POWER AMPLIFIER MODULE (MARINE FM)

FEATURES:

- . Output Power : $P_o \geqq 28W$
- . Minimum Gain : Gp=21.4dB
- . Efficiency : $\eta_T \geqq 45\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	−
EIAJ	−
TOSHIBA	5−53C

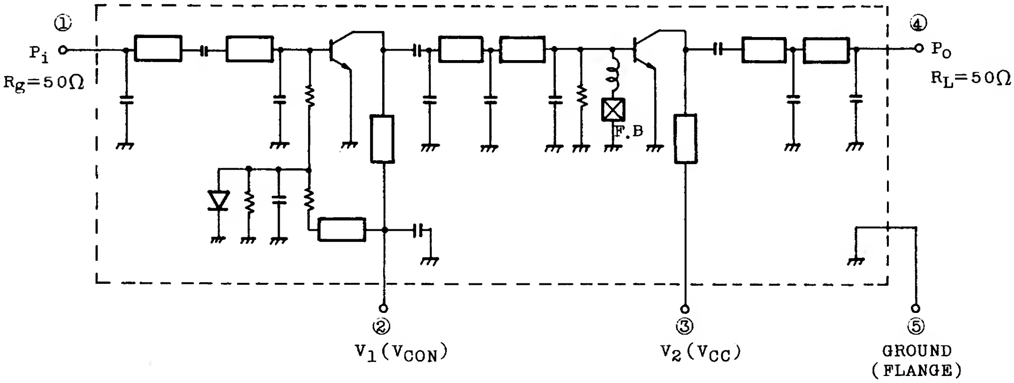
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	−30 ~ 100	°C
Storage Temperature Range	T_{stg}	−40 ~ 110	°C

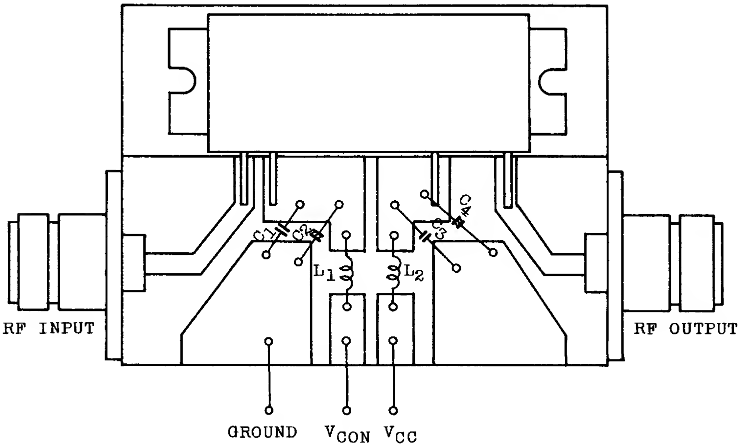
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	154	-	162	MHz
Output Power	P_o	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V $Z_g=Z_l$=50Ω	28	33	-	W
Power Gain	Gp		21.4	22.2	-	dB
Total Efficiency	η_T		45	50	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_o=30W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

SCHEMATIC



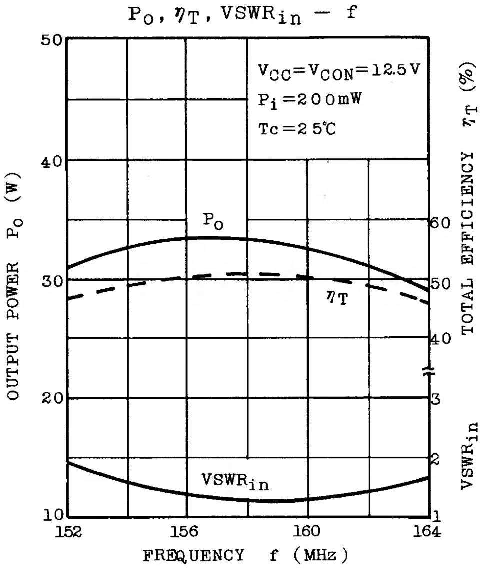
TEST MOUNT

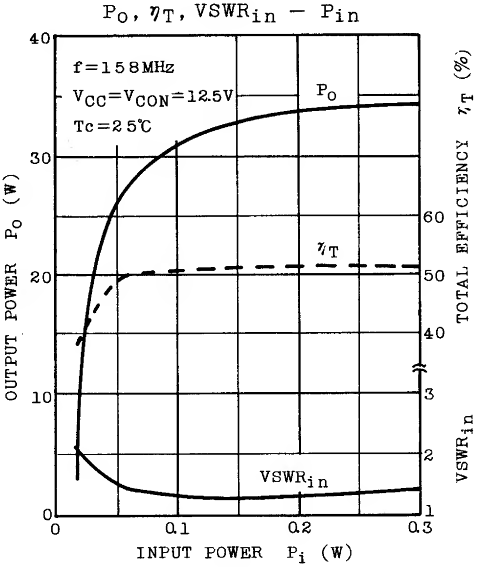


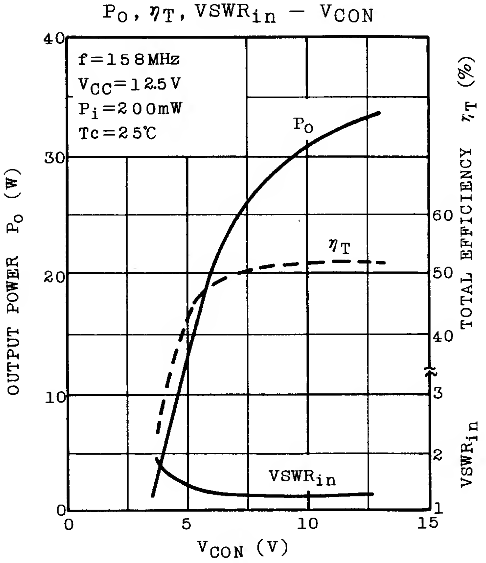
C_1, C_3 : 15000pF

C_2, C_4 : 1μF

L_1, L_2 : ∅0.8 Ag PLATED WIRE, 8T, 5ID


P_O, η_T, $VSWR_{in}$ — f
$V_{CC}=V_{CON}=12.5V$
$P_i=200mW$
Tc=25℃
P_O
η_T
$VSWR_{in}$
OUTPUT POWER P_O (W)
TOTAL EFFICIENCY η_T (%)
$VSWR_{in}$
FREQUENCY f (MHz)
50
40
30
20
10
60
50
40
3
2
1
152
156
160
164


P_O, η_T, $VSWR_{in}$ — P_{in}
f=158MHz
$V_{CC}=V_{CON}=12.5V$
Tc=25℃
P_O
η_T
$VSWR_{in}$
OUTPUT POWER P_O (W)
TOTAL EFFICIENCY η_T (%)
$VSWR_{in}$
INPUT POWER P_i (W)
40
30
20
10
0
60
50
40
3
2
1
0
0.1
0.2
0.3

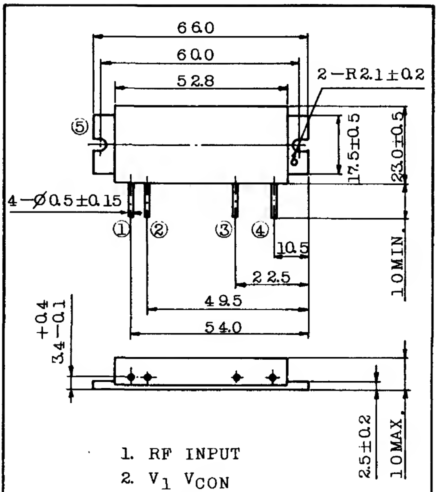

P_O, η_T, $VSWR_{in}$ — V_{CON}
f=158MHz
$V_{CC}=12.5V$
$P_i=200mW$
Tc=25℃
P_O
η_T
$VSWR_{in}$
OUTPUT POWER P_O (W)
TOTAL EFFICIENCY η_T (%)
$VSWR_{in}$
V_{CON} (V)
40
30
20
10
0
60
50
40
3
2
1
0
5
10
15

TOSHIBA RF POWER AMPLIFIER MODULE

S-AV7

VHF POWER AMPLIFIER MODULE (HAM FM)

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53C

FEATURES:

- Output Power : $P_O \geqq 28W$
- Minimum Gain : Gp=21.4dB
- Efficiency : $\eta_T \geqq 45\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

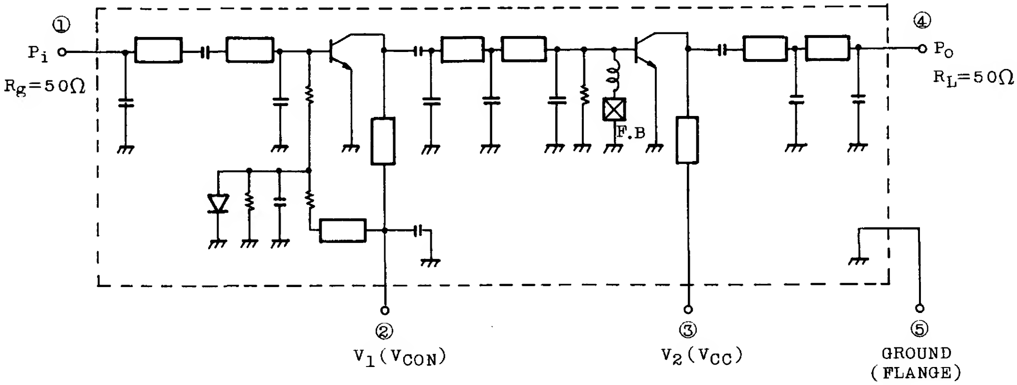
MAXIMUM RATINGS ($Tc=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30～100	°C
Storage Temperature Range	T_{stg}	-40～110	°C

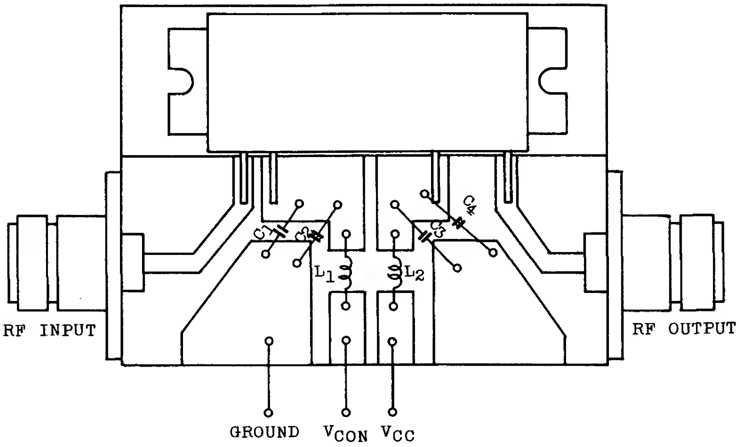
CHARACTERISTICS ($Tc=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_O	P_i=200mW V_{CC}=12.5V, V_{CON}=1.25V $Z_g=Z_l$=50Ω	28	33	-	W
Power Gain	Gp		21.4	22.2	-	dB
Total Efficiency	η_T		45	52	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_O=30W VSWR load 20:1 all phase	No Degradation			
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0～12.5V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			

SCHEMATIC



TEST MOUNT

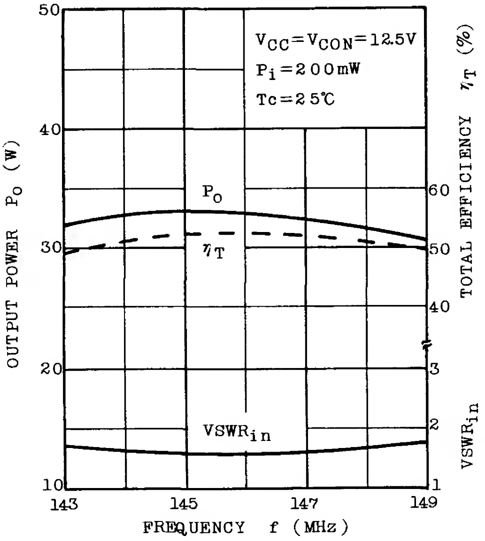


C_1, C_3 : 15000pF

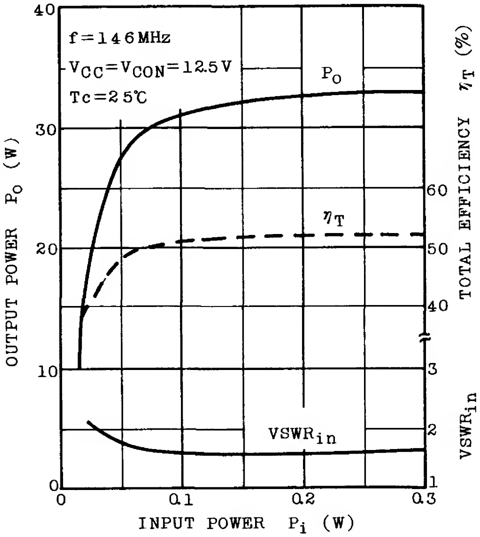
C_2, C_4 : 1µF

L_1, L_2 : ∅0.8 Ag PLATED WIRE, 8T, 5ID

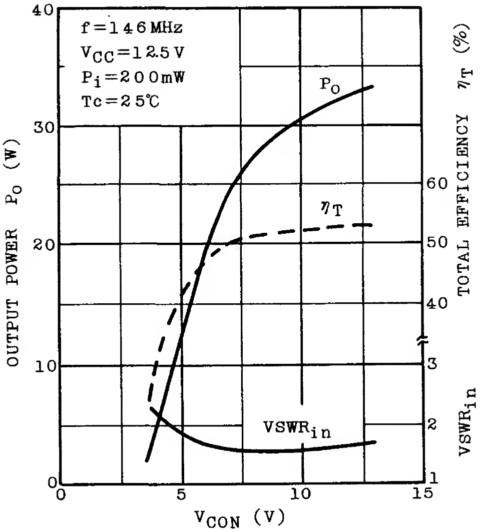
P_O, η_T, $VSWR_{in}$ − f



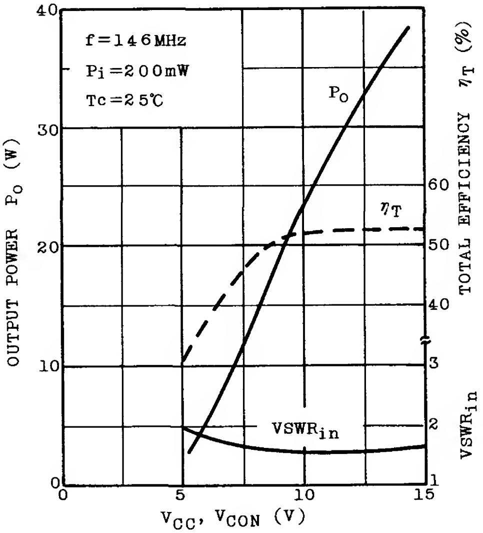
P_O, η_T, $VSWR_{in}$ − P_{in}



P_O, η_T, $VSWR_{in}$ − V_{CON}



P_O, η_T, $VSWR_{in}$ − V_{CC}, V_{CON}



S-AV8

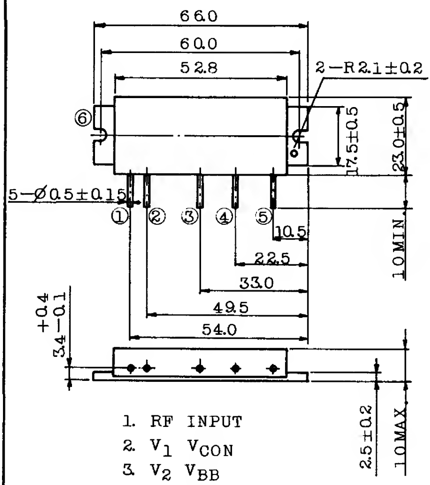
TOSHIBA RF POWER AMPLIFIER MODULE

VHF POWER AMPLIFIER MODULE (HAM SSB/FM)

Unit in mm

FEATURES:

- Output Power : $P_o \geqq 17W$
- Minimum Gain : Gp=19.2dB
- Efficiency : $\eta_T \leqq 40\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{BB}
4. V_3 V_{CC}
5. RF OUTPUT
6. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53B

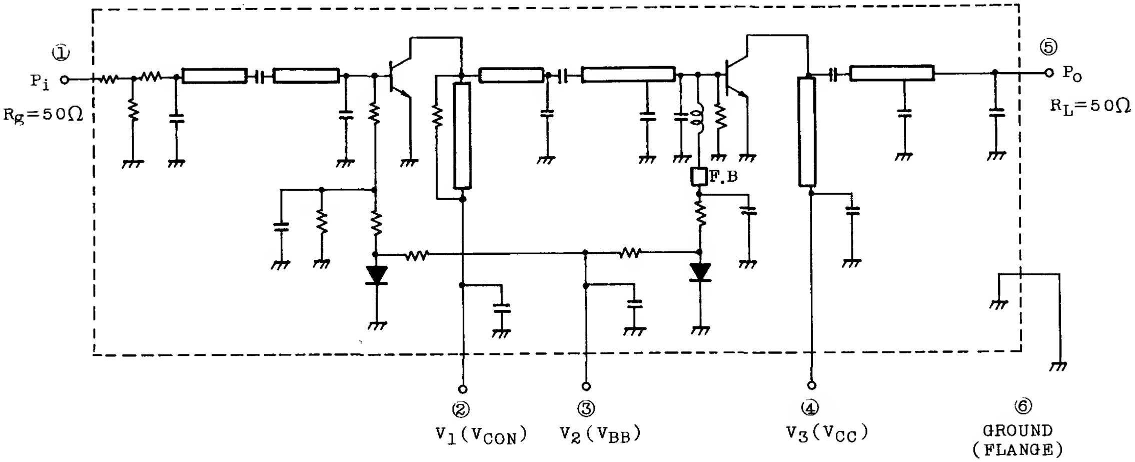
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	Tc(OP)	-30 ~ 100	°C
Storage Temperature Range	T_{stg}	-40 ~ 110	°C

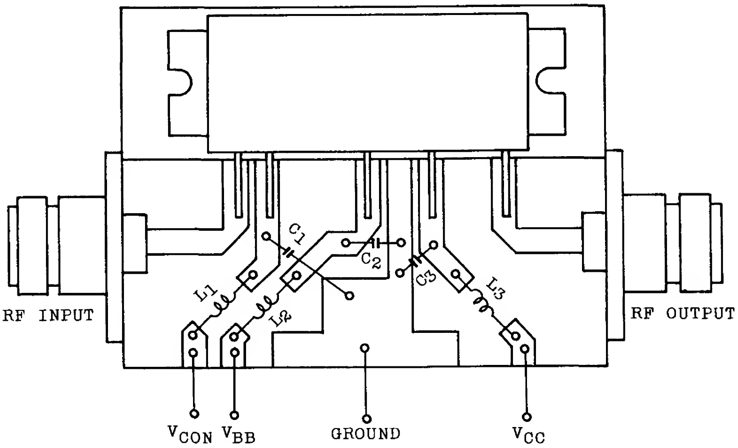
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_o	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V $Z_g=Z_l$=50Ω, V_{BB}=9V	17	22	-	W
Power Gain	Gp		19.2	20.4	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_o=18W, V_{BB}=9V VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V, V_{BB}=9V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-
Intermodulation Distortion Ratio	IMD	f_1=440.000MHz, f_2=440.002MHz $V_{CC}=V_{CON}$=12.5V, V_{BB}=9V $P_o=13W_{PEP}$	-	-32	-	dB

SCHEMATIC



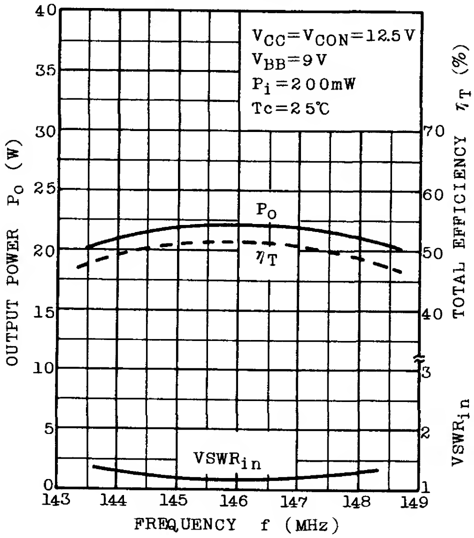
TEST MOUNT



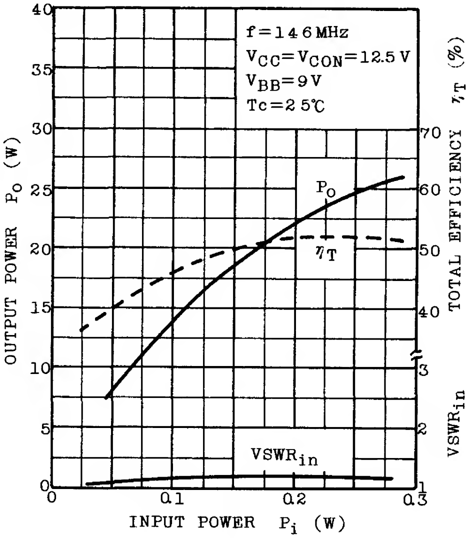
C_1, C_2, C_3 : 1500pF, 10μF PARALLEL

L_1, L_2, L_3 : Ø0.8 Ag PLATED WIRE, 8T, 5ID

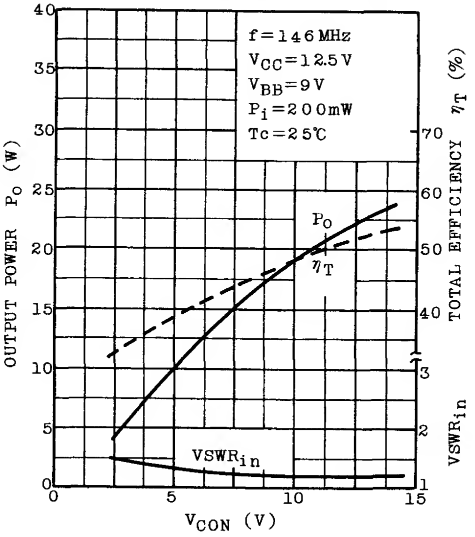
P_O, η_T, $VSWR_{in}$ — f



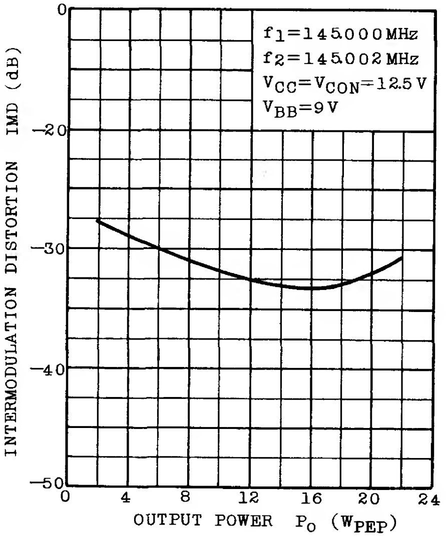
P_O, η_T, $VSWR_{in}$ — P_i



P_O, η_T, $VSWR_{in}$ — V_{CON}



IMD — P_O

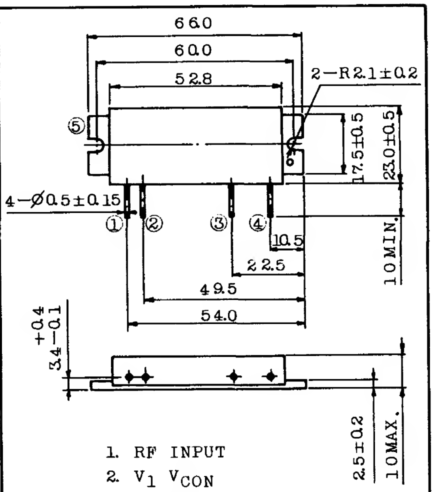


TOSHIBA RF POWER AMPLIFIER MODULE

S-AV9L
S-AV9H

VHF POWER AMPLIFIER MODULE

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53C

FEATURES:

- Output Power : $P_O \geqq 8W$
- Minimum Gain : G_p=16dB
- Efficiency : $\eta_T \geqq 40\%$
- 50Ω Input and Output Impedance
- Guaranteed Stability

MAXIMUM RATINGS (Tc=25°C)

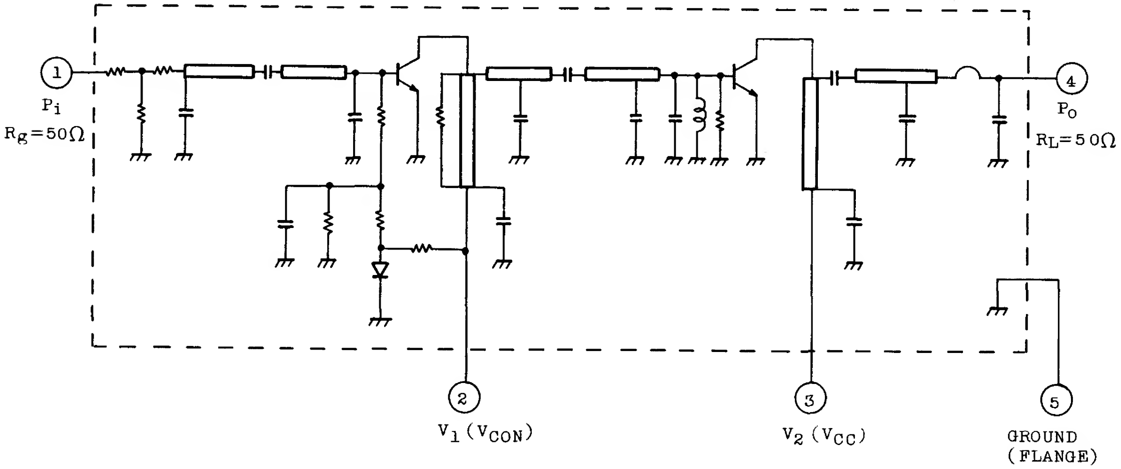
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_{C(OP)}$	−30 ~ 100	°C
Storage Temperature Range	T_{stg}	−40 ~ 110	°C

CHARACTERISTICS (Tc=25°C)

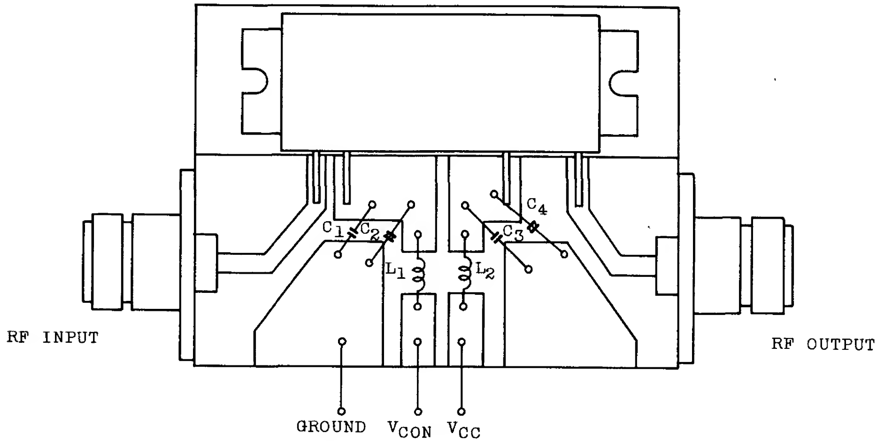
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f_{range}	-	135	-	175	MHz
Output Power	P_o	P_i=200mW V_{CO}=12.5V, V_{CON}=12.5V Z_g=Z_1=50Ω	8	-	-	W
Power Gain	Gp		16	-	-	dB
Total Efficiency	η_T		40	-	-	%
Input VSWR	$VSWR_{in}$		-	-	2	-
Harmonics	HRM		-	-	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_o=12W VSWR load 20:1 all phase	No Degradation			—
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			—

(1) Frequency range is covered in two bands S-AV9L 135-155MHz
S-AV9H 150-175MHz

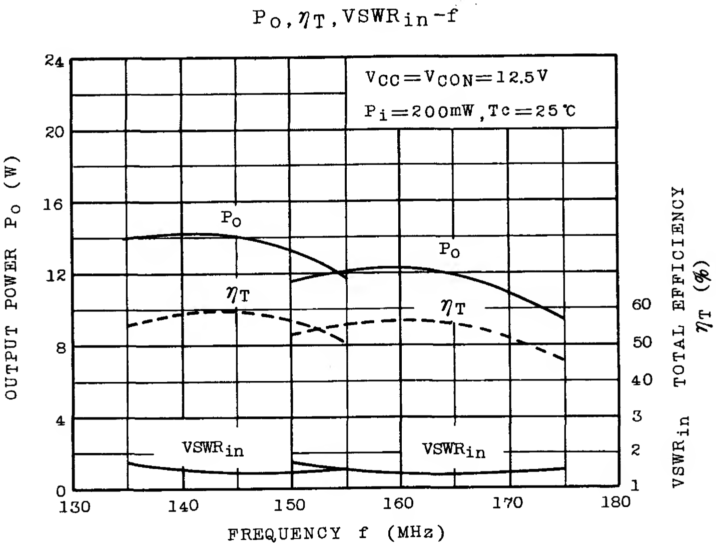
SCHEMATIC



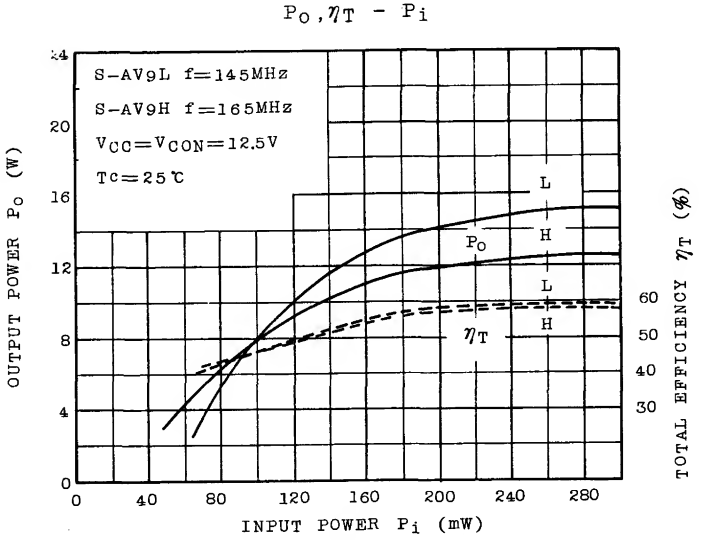
TEST MOUNT



C_1, C_3	15000pF
C_2, C_4	1μF
L_1, L_2	Ø0.8 COPPER WIRE 8T 5ID

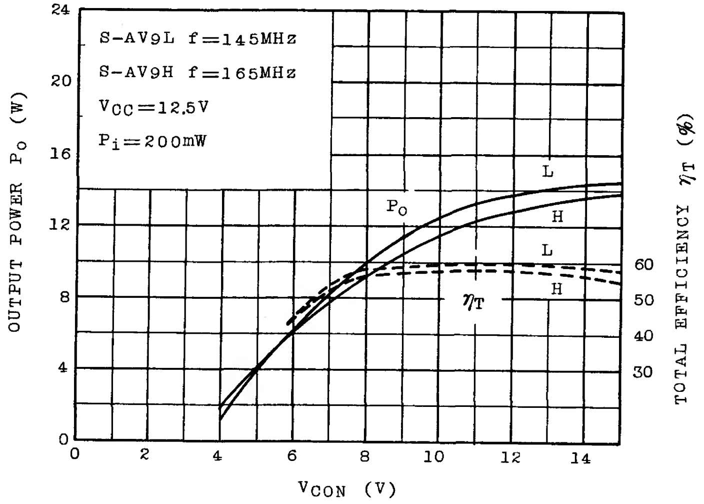


$P_O, \eta_T, VSWR_{in}$ - f
$V_{CC} = V_{CON} = 12.5V$
$P_i = 200mW, T_c = 25°C$
P_O
P_O
η_T
η_T
$VSWR_{in}$
$VSWR_{in}$
OUTPUT POWER P_O (W)
0
4
8
12
16
20
24
130
140
150
160
170
180
FREQUENCY f (MHz)
TOTAL EFFICIENCY η_T (%)
40
50
60
$VSWR_{in}$
1
2
3

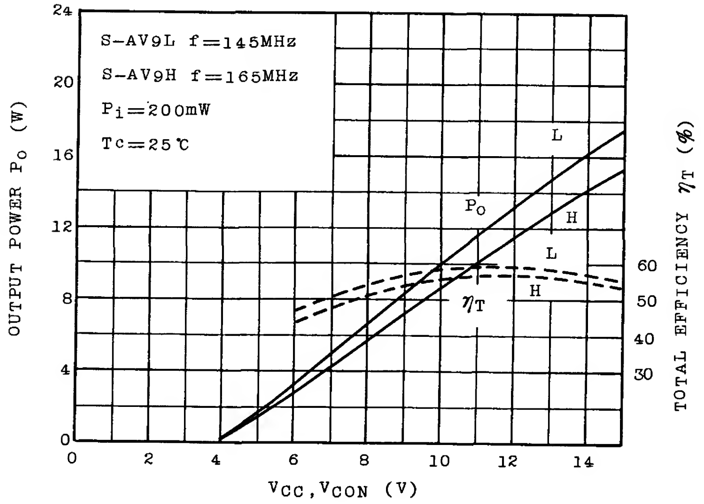


P_O, η_T - P_i
S-AV9L f=145MHz
S-AV9H f=165MHz
$V_{CC} = V_{CON} = 12.5V$
$T_c = 25°C$
L
H
L
H
P_O
η_T
OUTPUT POWER P_O (W)
0
4
8
12
16
20
24
0
40
80
120
160
200
240
280
INPUT POWER P_i (mW)
TOTAL EFFICIENCY η_T (%)
30
40
50
60

Po, ηT - VCON



Po, ηT - VCC, VCON



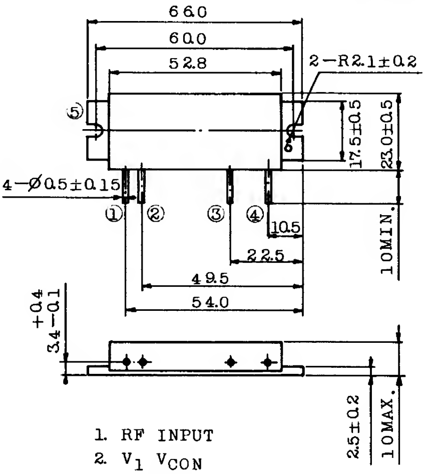
S-AV10L
S-AV10H

VHF POWER AMPLIFIER MODULE

FEATURES:

- Output Power : $P_O \geqq 14W$
- Minimum Gain : $G_P=18.5dB$
- Efficiency : $\eta_T \geqq 40\%$
- 50Ω Input and Output Impedance
- Guaranteed Stability

Unit in mm



1. RF INPUT
2. V_1 V_{CON}
3. V_2 V_{CC}
4. RF OUTPUT
5. GROUND (FLANGE)

JEDEC	—
EIAJ	—
TOSHIBA	5−53C

MAXIMUM RATINGS (Tc=25°C)

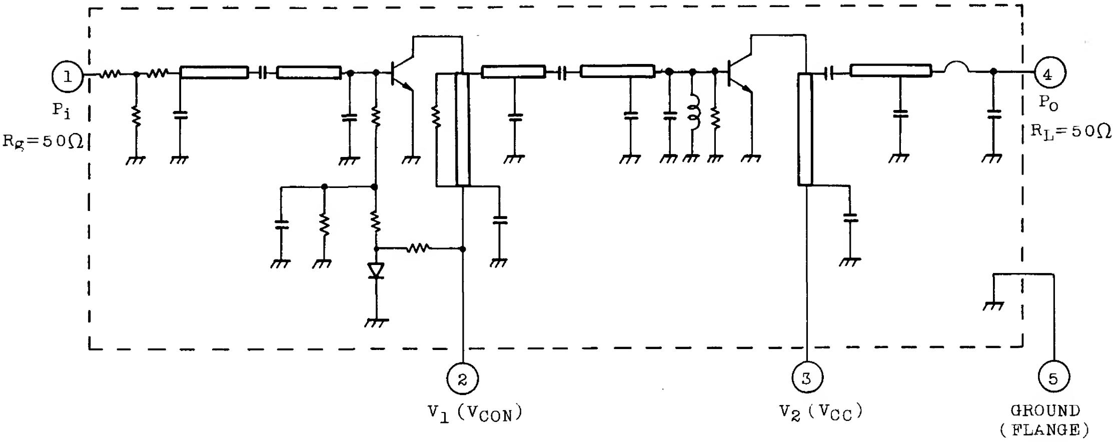
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_{C(OP)}$	-30 ~ 100	°C
Storage Temperature Range	Tstg	-40 ~ 110	°C

CHARACTERISTICS (Tc=25°C)

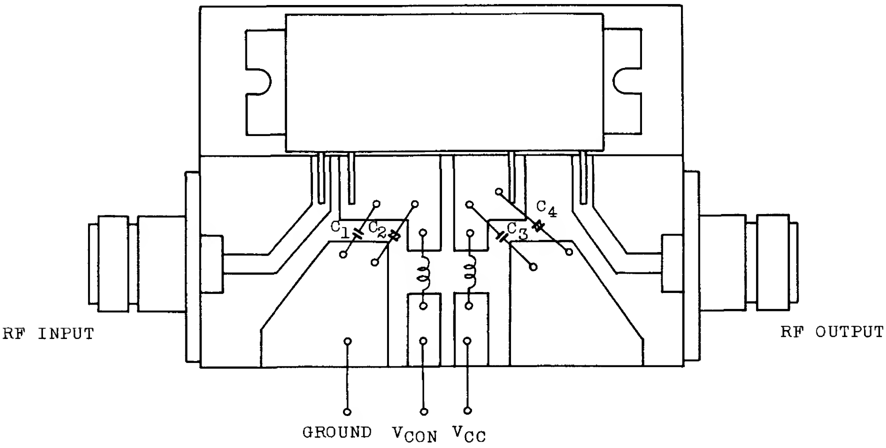
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f_{range}	-	135	-	175	MHz
Output Power	P_O	P_i=200mW V_{CC}=12.5V, V_{CON}=12.5V $Z_g=Z_l=50\Omega$	14	-	-	W
Power Gain	Gp		18.5	-	-	dB
Total Efficiency	η_T		40	-	-	%
Input VSWR	$VSWR_{in}$		-	-	2	-
Harmonics	HRM		-	-	-25	dB
Load Mismatch	-	V_{CC}=15V, V_{CON}=12.5V P_O=15W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V_{CC}=12.5V, P_i=200mW V_{CON}=0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

(1) Frequency range is covered in two bands S-AV10L 135-155MHz
S-AV10H 150-175MHz

SCHEMATIC

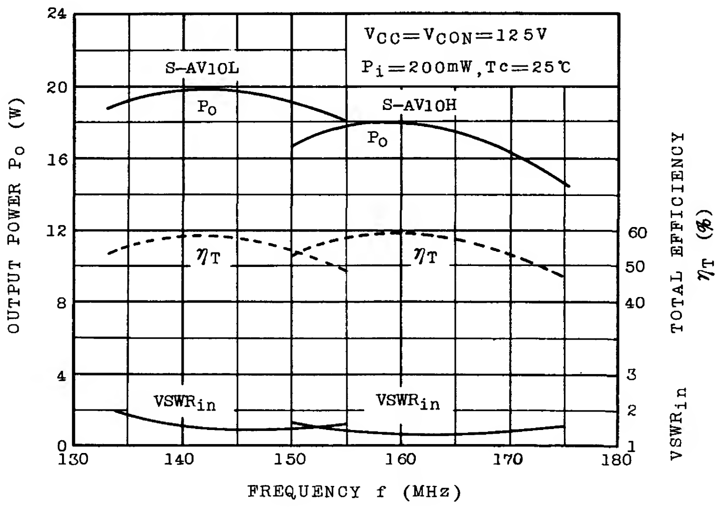


TEST MOUNT

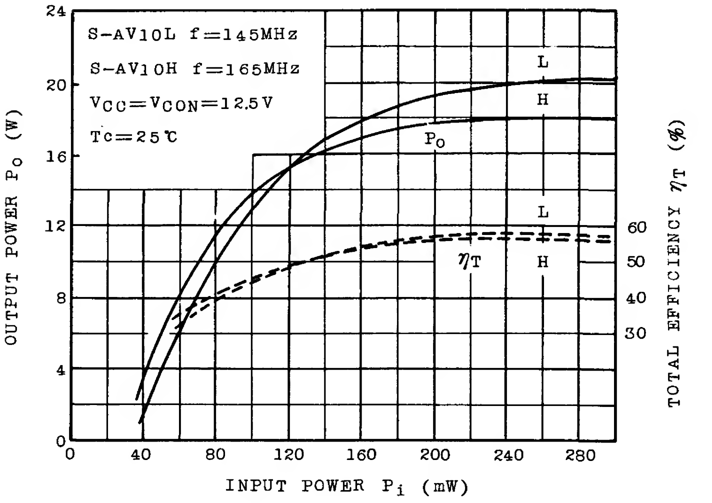


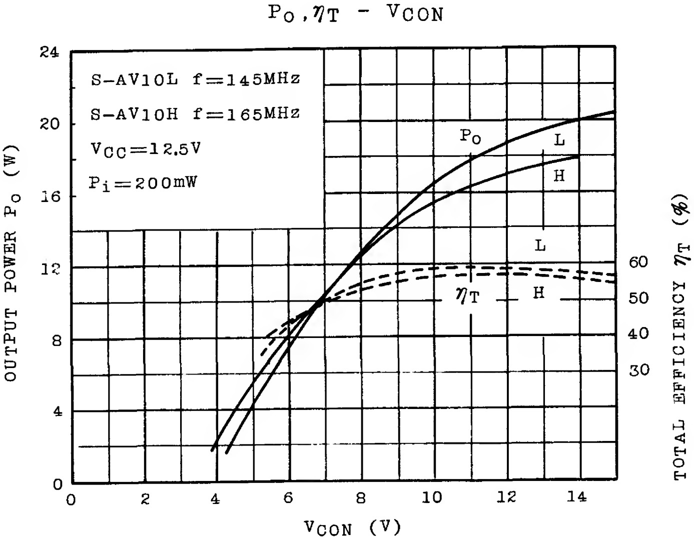
C_1, C_3	15000pF
C_2, C_4	1 μF
L_1, L_2	Ø0.8 COPPER WIRE 8T 5ID

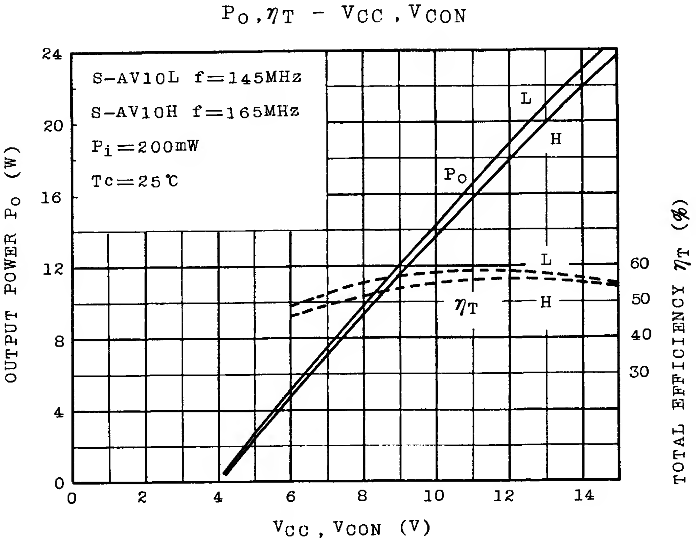
$P_O, \eta_T, VSWR_{in} - f$



$P_O, \eta_T - P_i$




Po , ηT - VCON
S-AV10L f=145MHz
S-AV10H f=165MHz
VCC=12.5V
Pi=200mW
OUTPUT POWER Po (W)
TOTAL EFFICIENCY ηT (%)
VCON (V)
Po
L
H
L
ηT
H
0
4
8
12
16
20
24
0
2
4
6
8
10
12
14
30
40
50
60


Po , ηT - VCC , VCON
S-AV10L f=145MHz
S-AV10H f=165MHz
Pi=200mW
Tc=25℃
OUTPUT POWER Po (W)
TOTAL EFFICIENCY ηT (%)
VCC , VCON (V)
Po
L
H
L
ηT
H
0
4
8
12
16
20
24
0
2
4
6
8
10
12
14
30
40
50
60

MG
SERIES

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

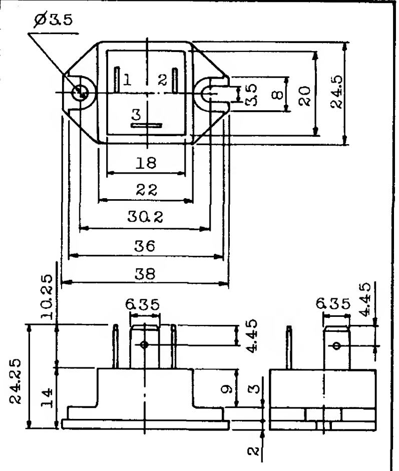
MG15G1AL3

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- With Built-in Free Wheeling Diode.
- High DC Current Gain : h_{FE}=100(Min.) (I_C=15A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.) (I_C=15A)
- High Speed : t_f=2μs(Max.) (I_C=15A)

Unit in mm

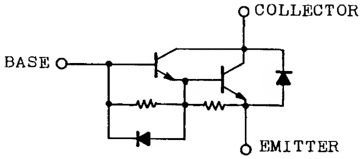


1. BASE
2. EMITTER
3. COLLECTOR

JEDEC	—
EIAJ	—
TOSHIBA	2-22B1A

Weight : 28g

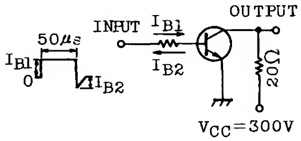
EQUIVALENT CIRCUIT

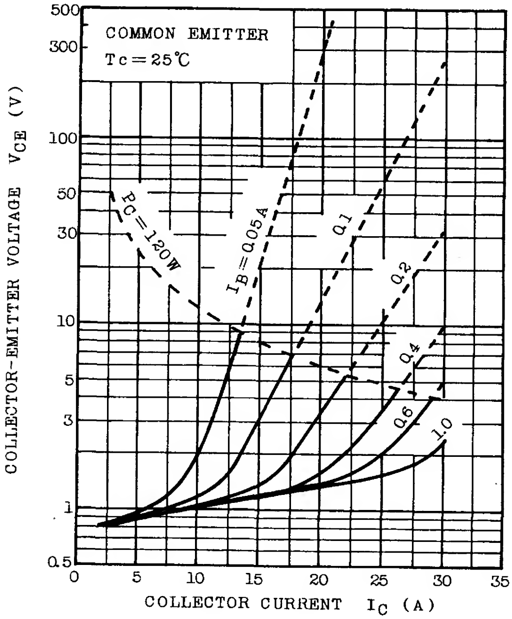


MAXIMUM RATINGS (Ta=25°C)

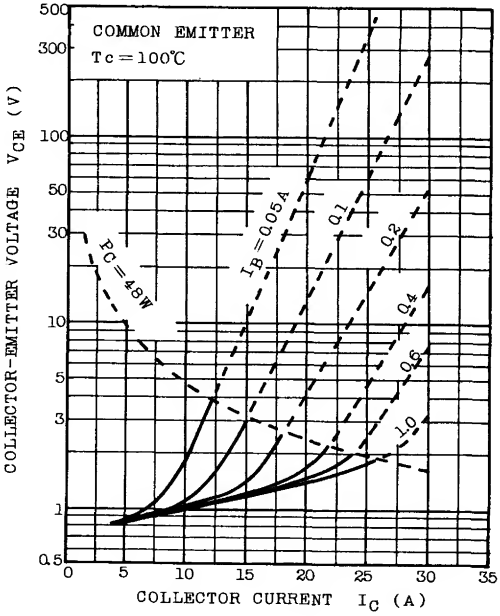
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		V_{CEO}	600	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	15	A
	1ms	I_C	30	A
	DC	$-I_C$	15	A
Base Current		I_B	1	A
Collector Power Dissipation (Tc=25°C)		P_C	120	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40～125	°C
Isolation Voltage		V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque			10	kg·cm

ELECTRICAL CHARACTERISTICS (Ta=25°C)

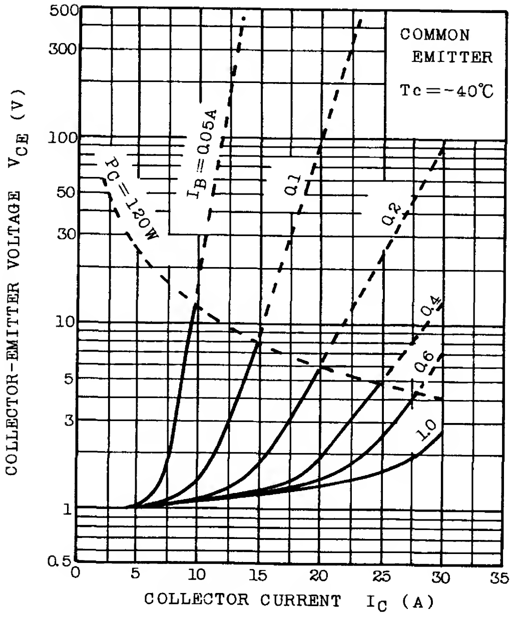
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	100	mA
Collector-Emitter Sastaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=15A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=15A, I_B=0.4A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	I_E=15A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=15A, V_{EB}=3V V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	190	-	pF
Switching Time	Turn-on Time	t_{on}	 OUTPUT INPUT I_{B1} I_{B2} 50μs I_{B1} 0 I_{B2} 20Ω V_{CC}=300V $I_{B1}=-I_{B2}$=0.4 A DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	1.0	°C/W
			Diode	-	-	3.5	



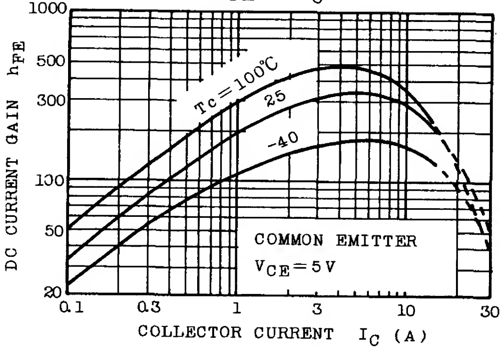
$V_{CE} - I_C$



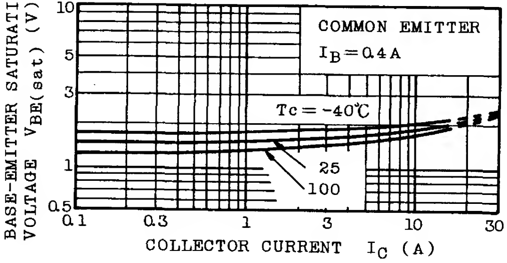
$V_{CE} - I_C$



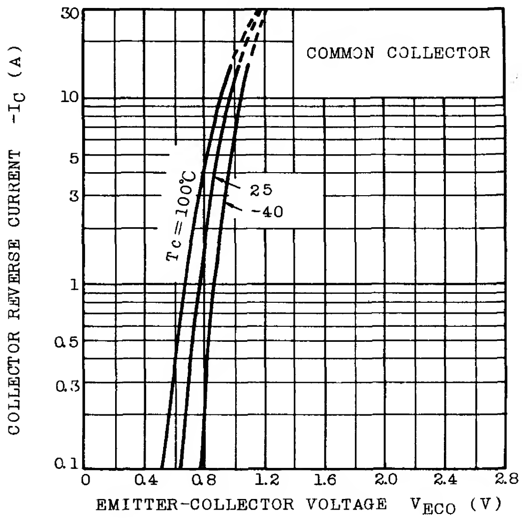
$V_{CE} - I_C$

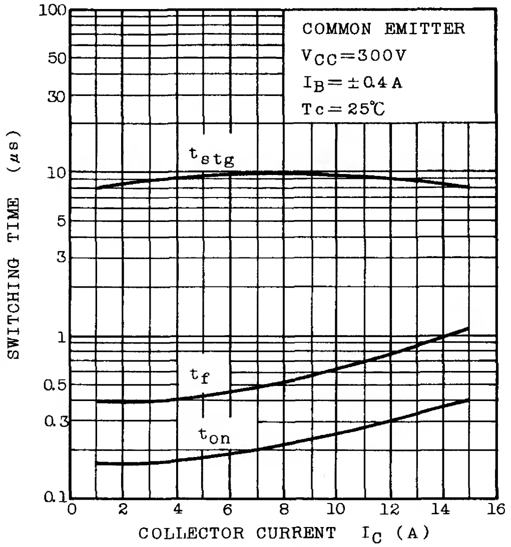


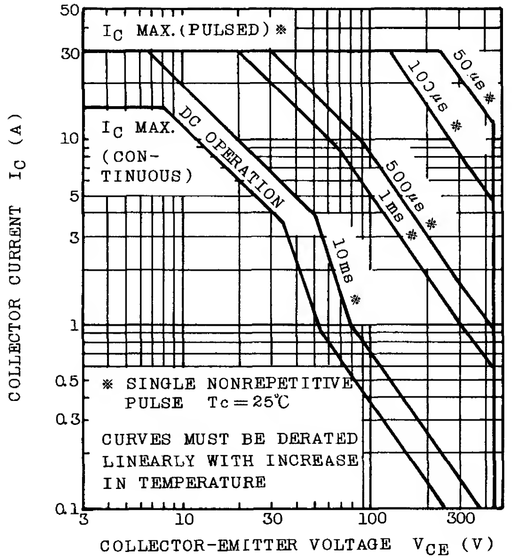
$h_{FE} - I_C$

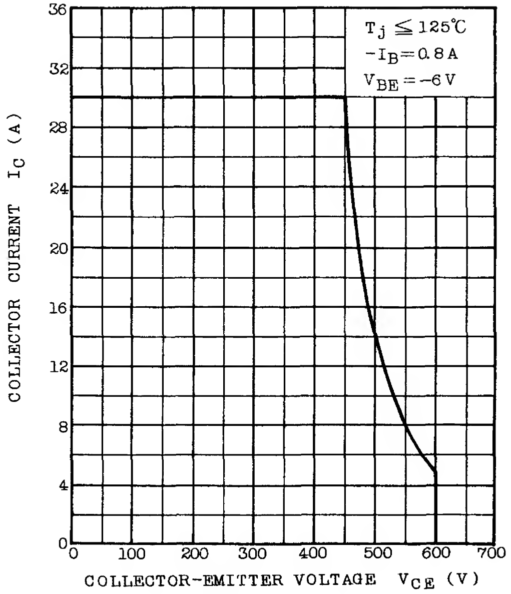


$V_{BE(sat)} - I_C$


$-I_C - V_{ECO}$


SWITCHING TIME – I_C


SAFE OPERATING AREA


REVERSE BIAS ASO

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

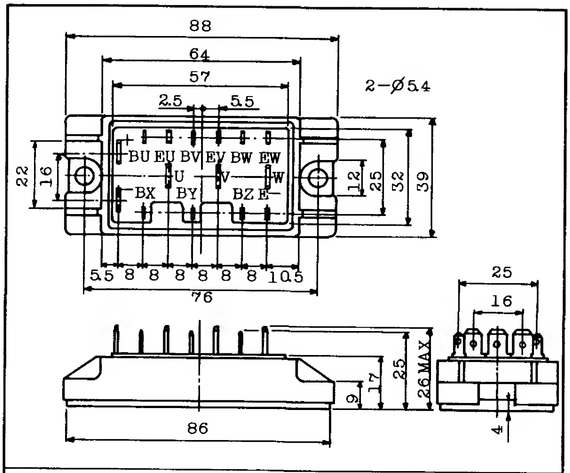
MG15G6EL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- 6 Darlington Transistor are Built-In to 1 Package.
- With Built-in Free Wheeling Diode.
- High DC Current Gain
  : $h_{FE}=100$(Min.) ($I_C=15A$)
- Low Saturation Voltage
  : $V_{CE(sat)}=2V$(Max.) ($I_C=15A$)
- High Speed : $t_f=2\mu s$(Max.) ($I_C=15A$)

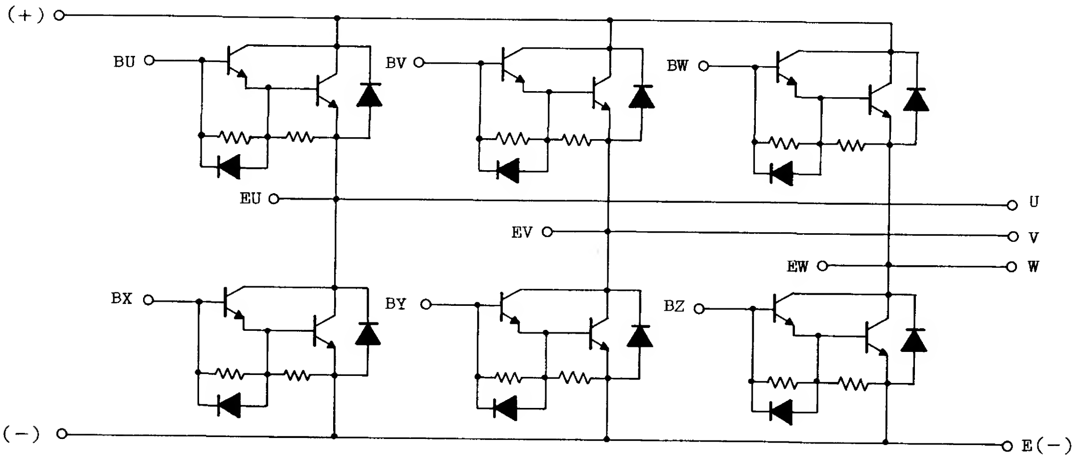
Unit in mm



JEDEC	−
EIAJ	−
TOSHIBA	2−64A1A

Weight : 180g

EQUIVALENT CIRCUIT

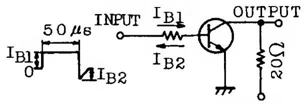


MG15G6EL1

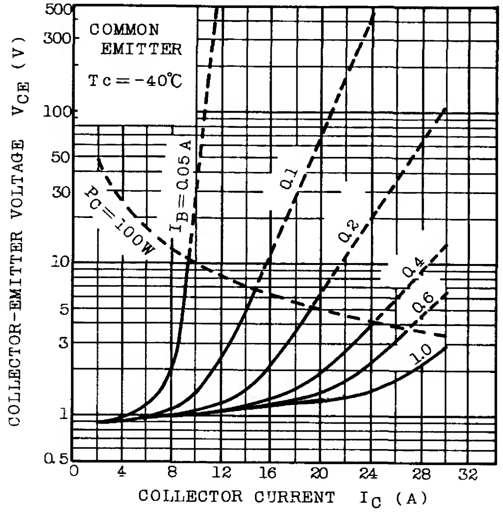
MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		V_{CEO}	600	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	15	A
	1ms	I_C	30	A
	DC	$-I_C$	15	A
Base Current		I_B	1	A
Collector Power Dissipation (Tc=25°C)		P_C	100	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-40 ~ 125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torgue			30	kg·cm

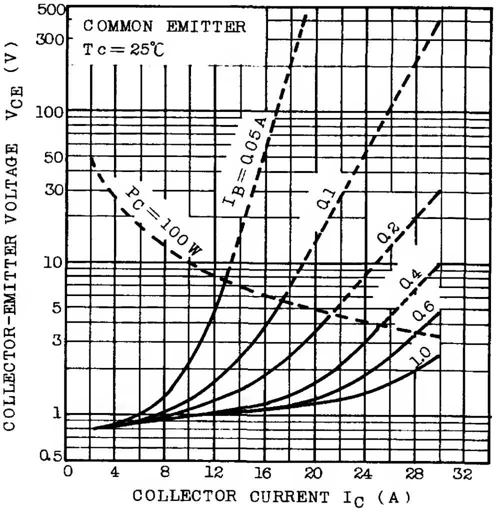
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	100	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=15A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=15A, I_B=0.4A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	I_E=15A, I_B=0	-	-	1.6	V
Reverse Recovery Time			$-I_C$=15A, V_{EB}=2V, V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		Cob	V_{CB}=50V, I_E=0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	ton	 50μs INPUT I_{B1} OUTPUT I_{B1} 0 I_{B2} I_{B2} 20Ω V_{CC}=300V $I_{B1}=-I_{B2}$=0.4A DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	tstg		-	-	12	
	Fall Time	tf		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$		-	-	1.25	°C/W

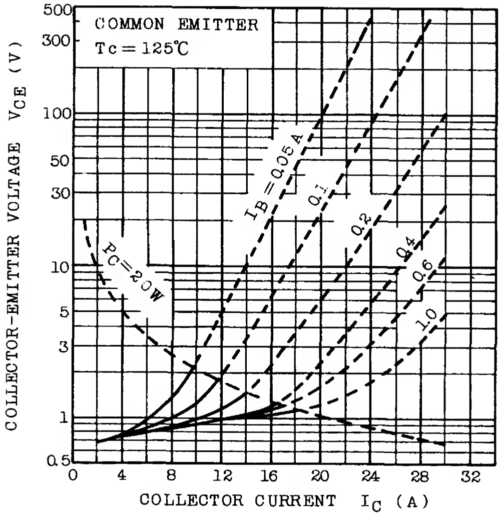
$V_{CE} - I_C$



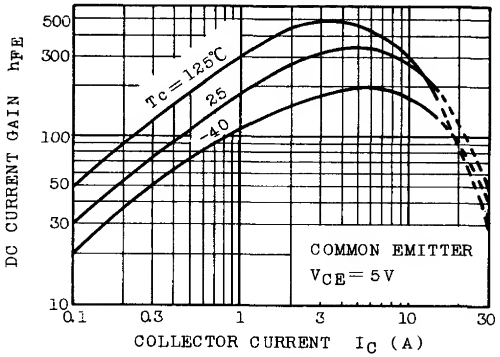
$V_{CE} - I_C$



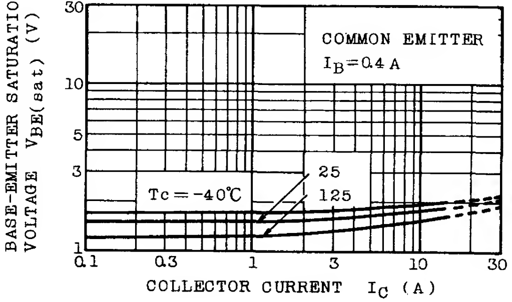
$V_{CE} - I_C$

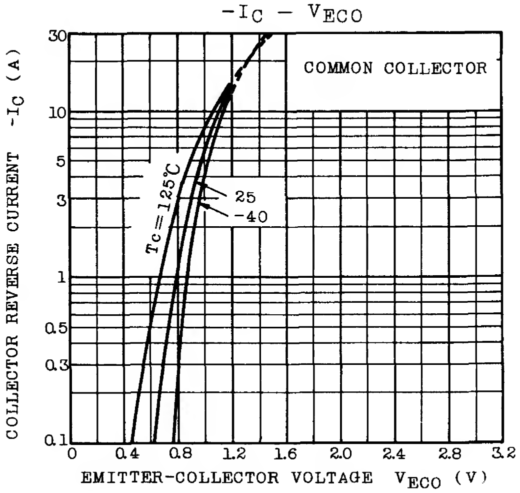


$h_{FE} - I_C$

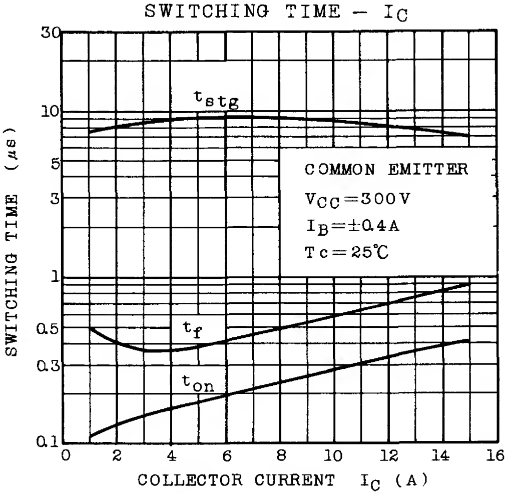


$V_{BE(sat)} - I_C$

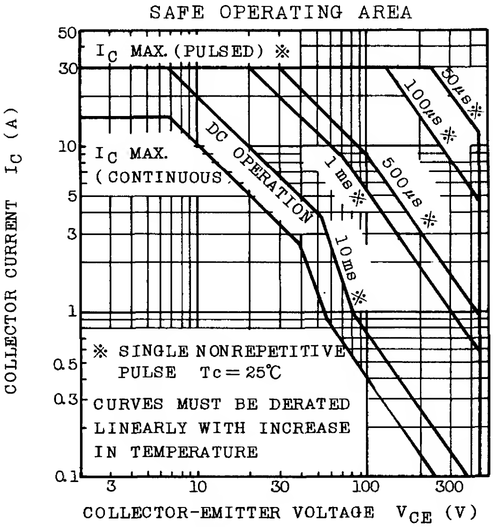




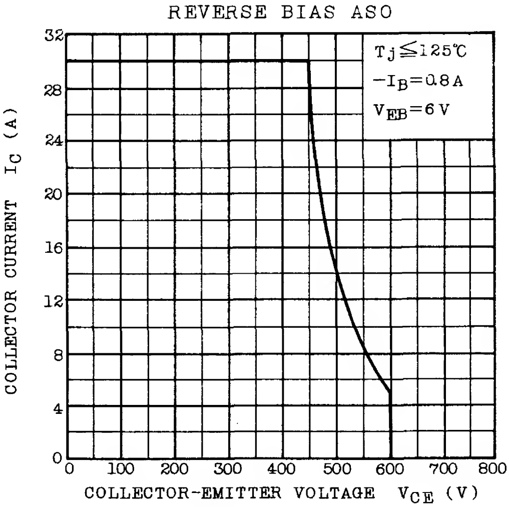
-Ic — VECO



SWITCHING TIME — IC



SAFE OPERATING AREA



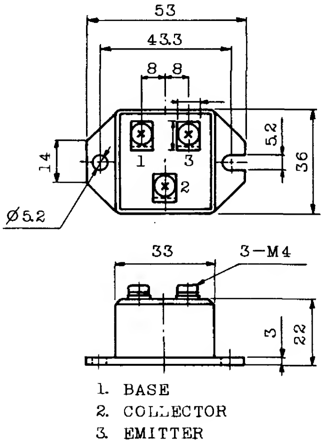
REVERSE BIAS ASO

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

MG30G1BL2

HGIH POWER SWITCHING APPLICATIONS.

Unit in mm

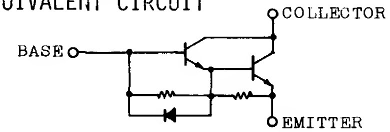


JEDEC	−
EIAJ	−
TOSHIBA	2−33B1A

Weight : 98g

FEATURES:
- The Collector is Isolated from Ground.
- High DC Current Gain : h_{FE}=100(Min.) (I_C=30A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.) (I_C=30A)
- High Speed : t_f=2µs(Max.) (I_C=30A)

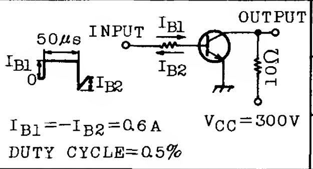
EQUIVALENT CIRCUIT

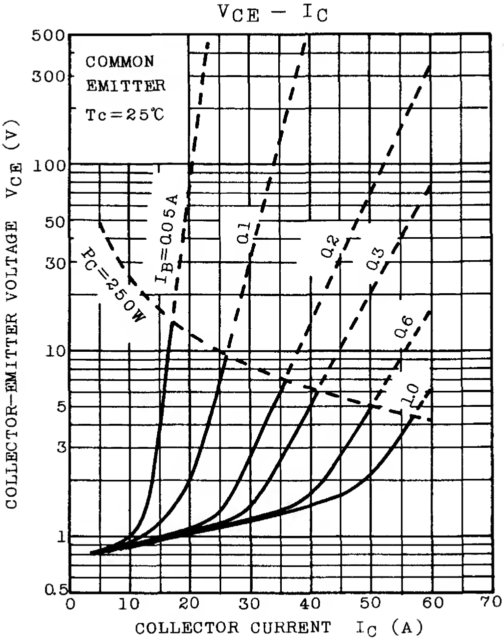


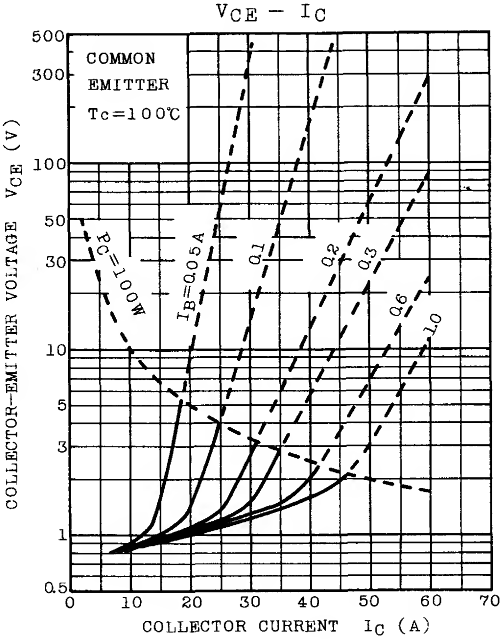
MAXIMUM RATINGS (Tc=25°C)

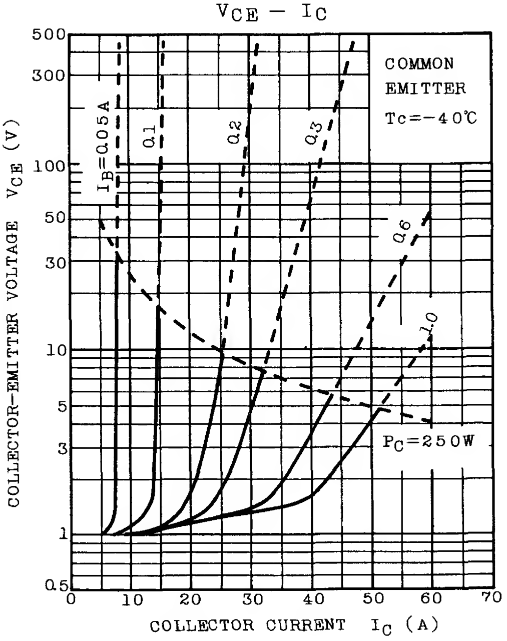
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	30	A
	Pulse	I_{CP}	60	A
Base Current		I_B	2	A
Collector Power Dissipation (Tc=25°C)		P_C	250	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−40 ∼ 125	°C
Isolation Voltage		V_{Isol}	2000 (AC 1Minute)	V
Screw Torque			20	kg·cm

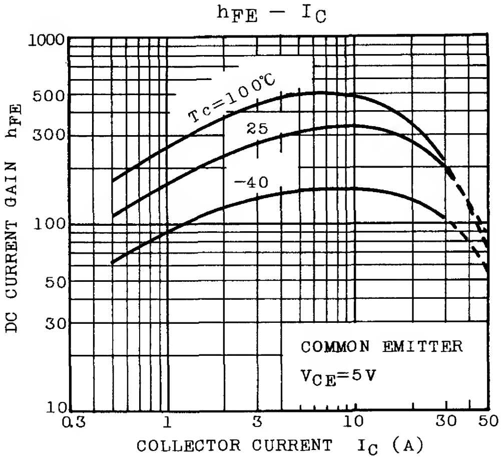
ELECTRICAL CHARACTERISTICS (Ta=25°C)

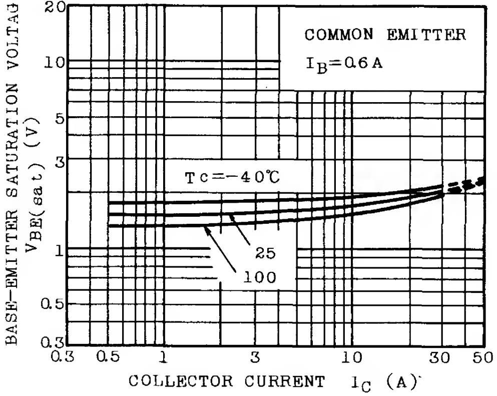
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=30A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=30A, I_B=0.6A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	 50µs INPUT I_{B1} OUTPUT I_{B1} 0 I_{B2} I_{B2} 10Ω I_{B1}=−I_{B2}=0.6A V_{CC}=300V DUTY CYCLE=0.5%	-	-	1.0	µs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance		$R_{th(j-c)}$	Junction to Case	-	-	0.5	°C/W


VCE − IC
COMMON EMITTER
Tc=25℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB=0.05A
0.1
0.2
0.3
0.6
1.0
PC=250W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70

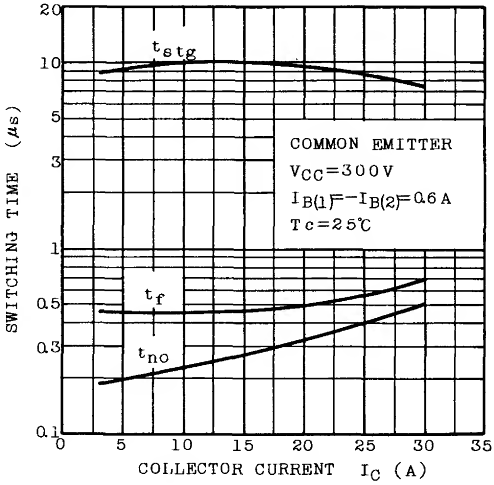

VCE − IC
COMMON EMITTER
Tc=100℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB=0.05A
0.1
0.2
0.3
0.6
1.0
PC=100W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70


VCE − IC
COMMON EMITTER
Tc=−40℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB=0.05A
0.1
0.2
0.3
0.6
1.0
PC=250W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70

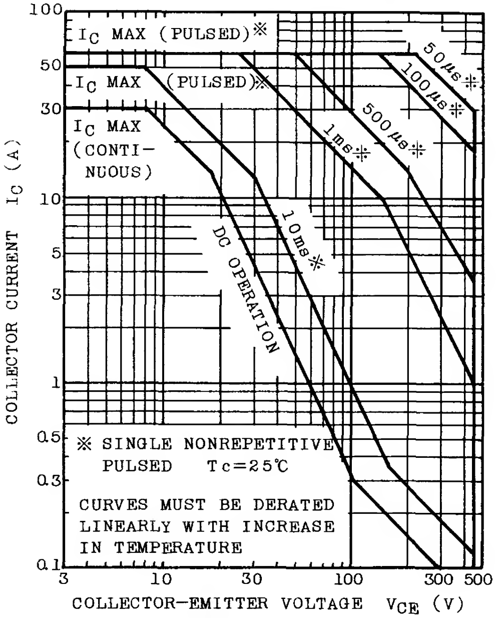

hFE − IC
DC CURRENT GAIN hFE
COLLECTOR CURRENT IC (A)
Tc=100℃
25
−40
COMMON EMITTER
VCE=5V
1000
500
300
100
50
30
10
0.3
1
3
10
30
50



VBE(sat) − IC



SWITCHING CHARACTERISTIC



SAFE OPERATING AREA

MG30G2CL3

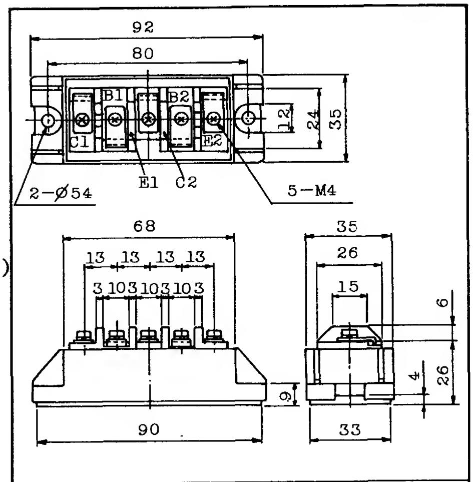
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- 2 Power Transistor and 2 Free Wheeling Diods are Built-in to 1 Package.
- High DC Current Gain : h_{FE}=100(Min.) (I_C=30A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.)(I_C=30A)
- High Speed : t_f=2μs(Max.) (I_C=30A)

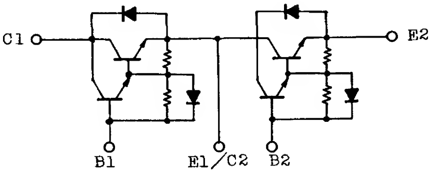
Unit in mm



JEDEC	―
EIAJ	―
TOSHIBA	2−68A1A

Weight : 210g

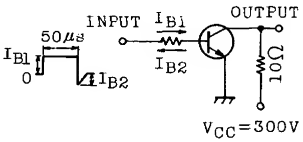
EQUIVALENT CIRCUIT

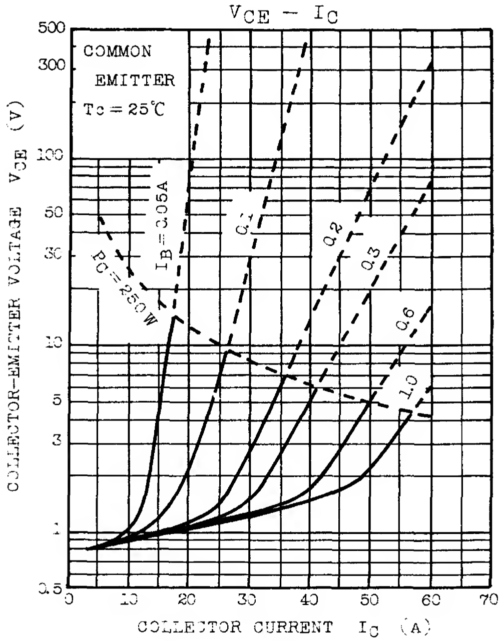


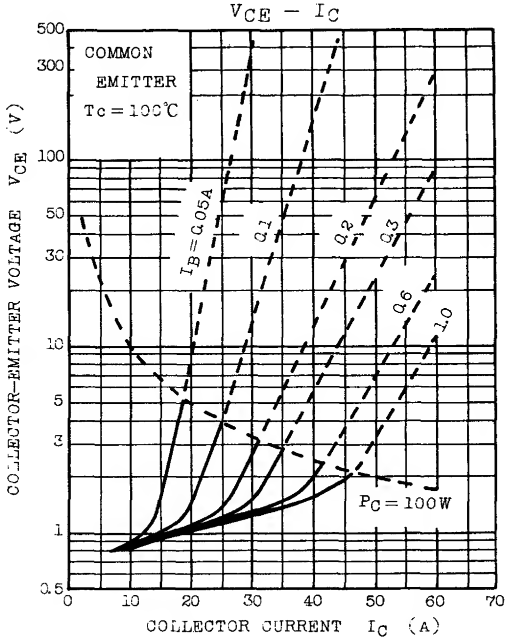
MAXIMUM RATINGS (Ta=25°C)

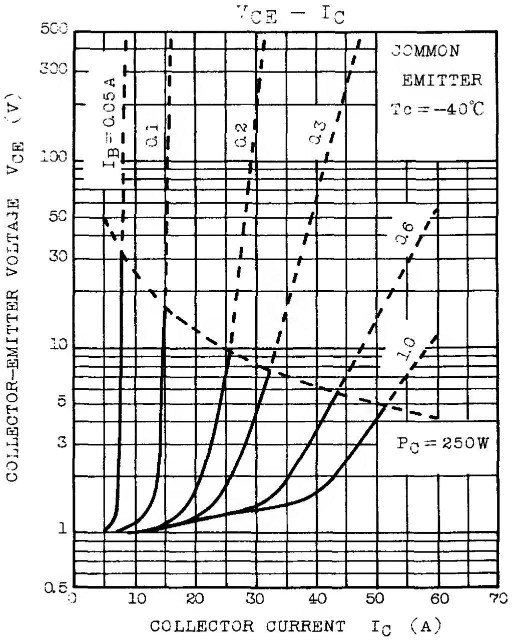
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector- Emitter Voltage		V_{CEO}	600	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	30	A
	1ms	I_C	60	A
	DC	$-I_C$	30	A
Base Current		I_B	2.0	A
Collector Power Dissipation (Tc=25°C)		P_C	250	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		Tstg	-40～125	°C
Isolation Voltage		V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque (Terminal/Mounting)			20/30	kg·cm

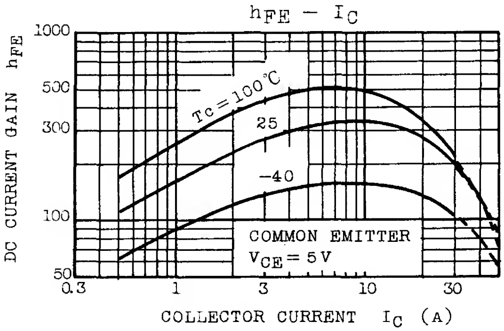
ELECTRICAL CHARACTERISTICS (Ta=25°C)

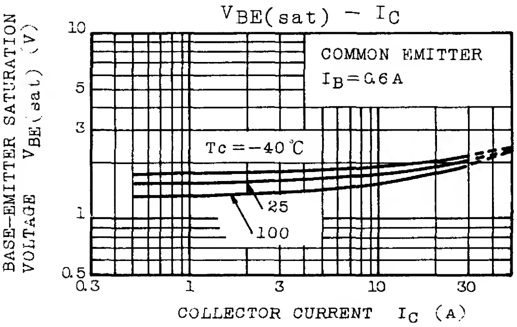
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=30A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=30A, I_B=0.6A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	I_E=30A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=30A, V_{EB}=3V V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	-	350	-	pF
Switching Time	Turn-on Tome	t_{on}	 INPUT I_{B1} OUTPUT 50μs I_{B1} 0 I_{B2} I_{B2} 10Ω V_{CC}=300V $I_{B1}=-I_{B2}$=0.6 A DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.5	°C/W
			Diode	-	-	1.8	


VCE − IC
COMMON EMITTER
Tc = 25℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB = 0.05A
0.1
0.2
0.3
0.6
1.0
PC = 250W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70

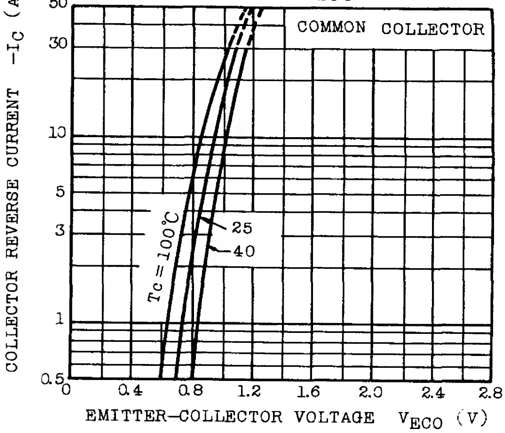

VCE − IC
COMMON EMITTER
Tc = 100℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB = 0.05A
0.1
0.2
0.3
0.6
1.0
PC = 100W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70


VCE − IC
COMMON EMITTER
Tc = −40℃
COLLECTOR-EMITTER VOLTAGE VCE (V)
COLLECTOR CURRENT IC (A)
IB = 0.05A
0.1
0.2
0.3
0.6
1.0
PC = 250W
500
300
100
50
30
10
5
3
1
0.5
0
10
20
30
40
50
60
70

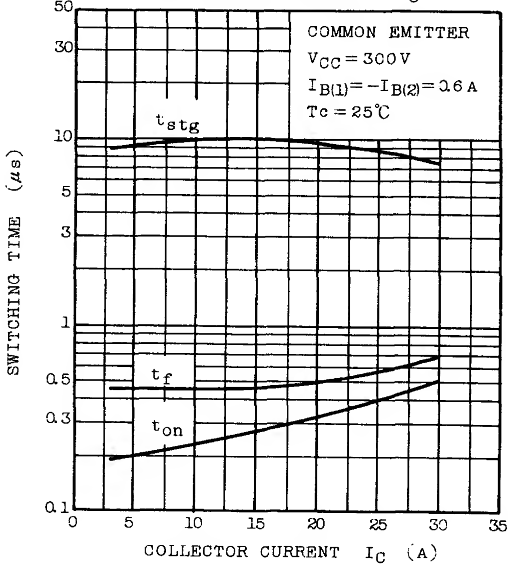

hFE − IC
DC CURRENT GAIN hFE
COLLECTOR CURRENT IC (A)
Tc = 100℃
25
−40
COMMON EMITTER
VCE = 5V
1000
500
300
100
50
0.3
1
3
10
30


VBE(sat) − IC
BASE-EMITTER SATURATION VOLTAGE VBE(sat) (V)
COLLECTOR CURRENT IC (A)
COMMON EMITTER
IB = 0.6A
Tc = −40℃
25
100
10
5
3
1
0.5
0.3
1
3
10
30

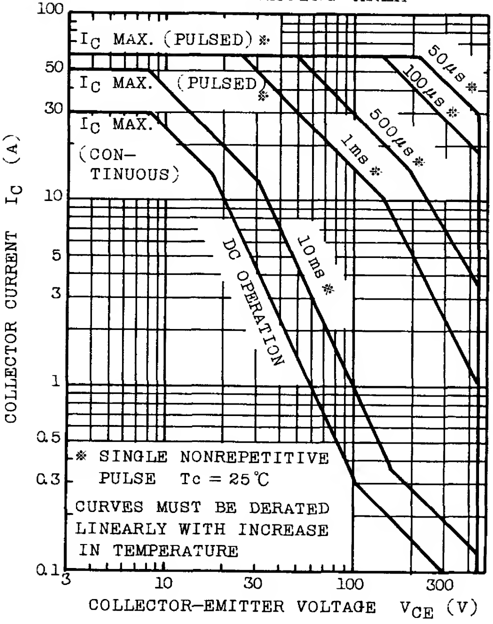
$-I_C - V_{ECO}$



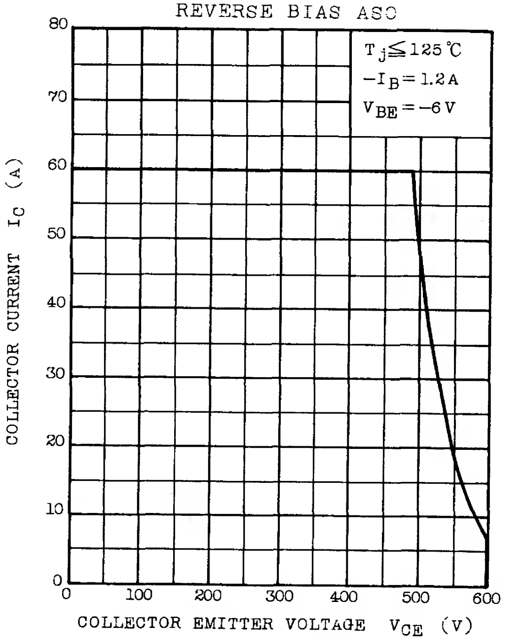
SWITCHING TIME − I_C



SAFE OPERATING AREA



REVERSE BIAS ASO



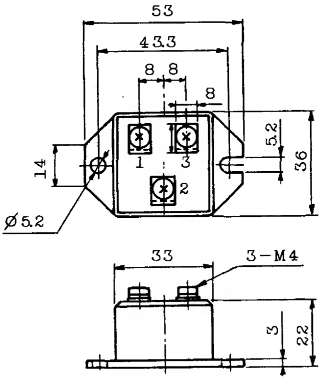
MG50G1BL2

SILICON NPN TRIPLE DIFFUSED TYPE (DARLINGTON POWER MODULE)

HIGH POWER SWITCHING APPLICATIONS.

FEATURES:
- The Collector is Isolated from Ground.
- High DC Current Gain : h_{FE}=100(Min.) (I_C=50A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.) (I_C=50A)
- High Speed : t_f=2µs(Max.) (I_C=50A)

Unit in mm



1. BASE
2. COLLECTOR
3. EMITTER

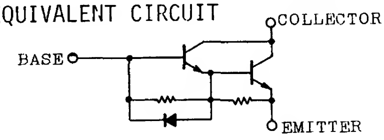
JEDEC	–
EIAJ	–
TOSHIBA	2-33B1A

Weight : 98g

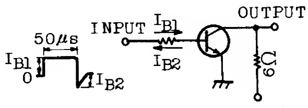
MAXIMUM RATINGS (T_c=25°C)

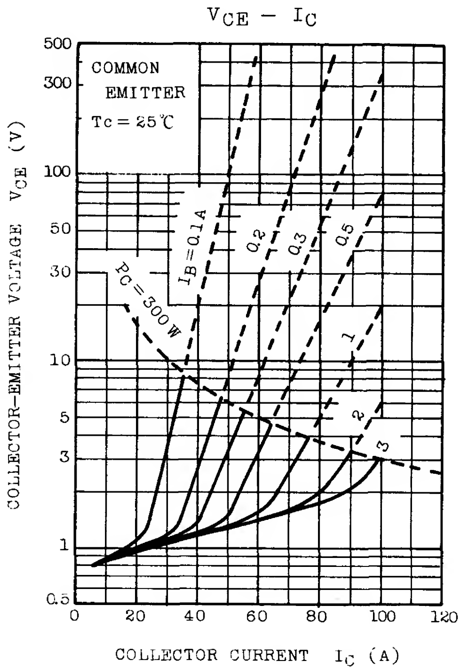
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	50	A
	Pulse	I_{CP}	100	A
Base Current		I_B	3	A
Collector Power Dissipation (T_c=25°C)		P_C	300	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40 ~ 125	°C
Isolation Voltage		V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque			20	kg·cm

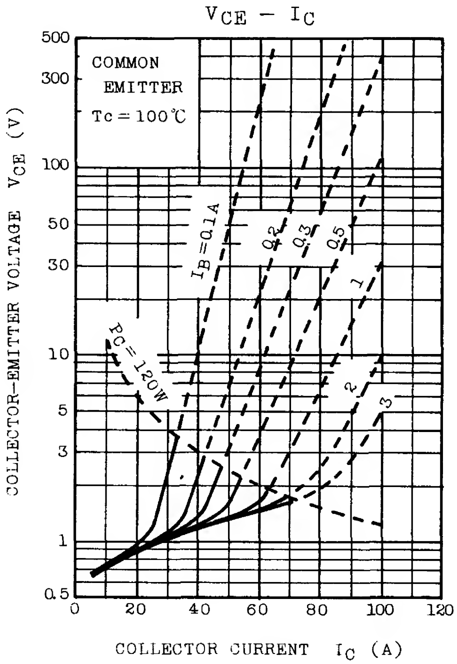
EQUIVALENT CIRCUIT

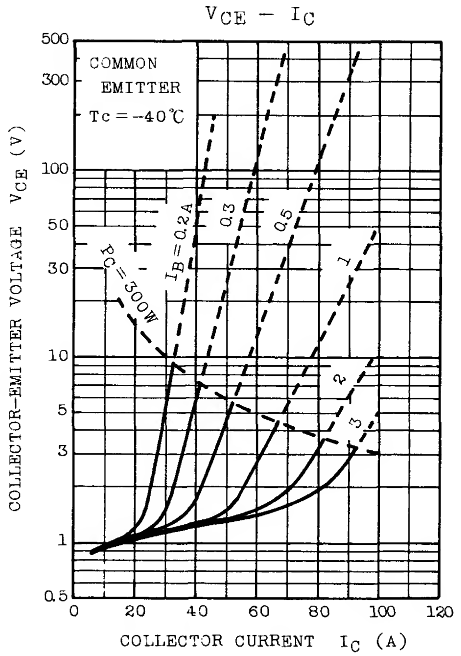


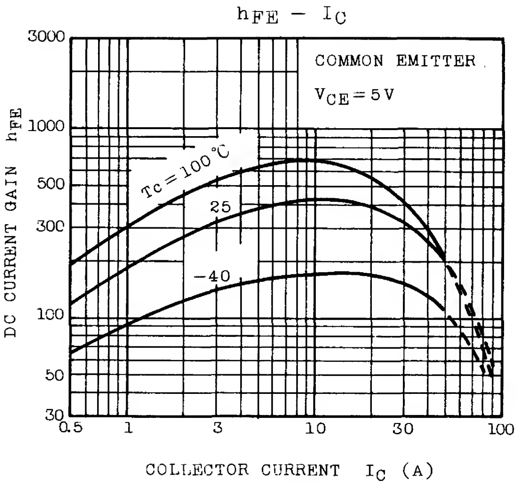
ELECTRICAL CHARACTERISTICS (T_a=25°C)

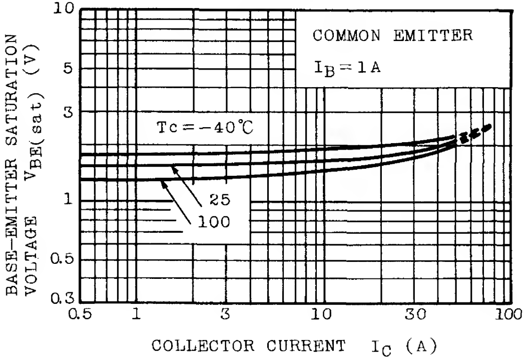
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	–	–	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	–	–	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	–	–	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=50A	100	–	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=50A, I_B=1A	–	–	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		–	–	2.5	V
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0, f=1MHz	–	450	–	pF
Switching Time	Turn-on Time	t_{on}	 OUTPUT INPUT I_{B1} I_{B2} 50µs 0 6Ω V_{CC}=300V I_{B1}=$-I_{B2}$=1A DUTY CYCLE=0.5%	–	–	1.0	µs
	Storage Time	t_{stg}		–	–	12	
	Fall Time	t_f		–	–	2.0	
Thermal Resistance		$R_{th(j-c)}$	Junction to Case	–	–	0.41	°C/W


VCE − IC
COMMON EMITTER
Tc = 25°C
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR CURRENT IC (A)
IB = 0.1A
0.2
0.3
0.5
1
2
3
PC = 300W

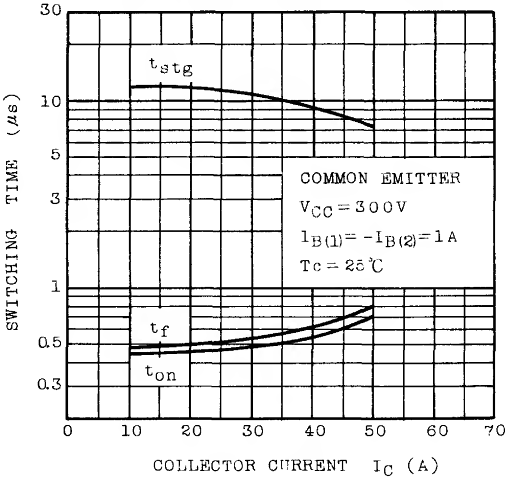

VCE − IC
COMMON EMITTER
Tc = 100°C
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR CURRENT IC (A)
IB = 0.1A
0.2
0.3
0.5
1
2
3
PC = 120W


VCE − IC
COMMON EMITTER
Tc = −40°C
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR CURRENT IC (A)
IB = 0.2A
0.3
0.5
1
2
3
PC = 300W

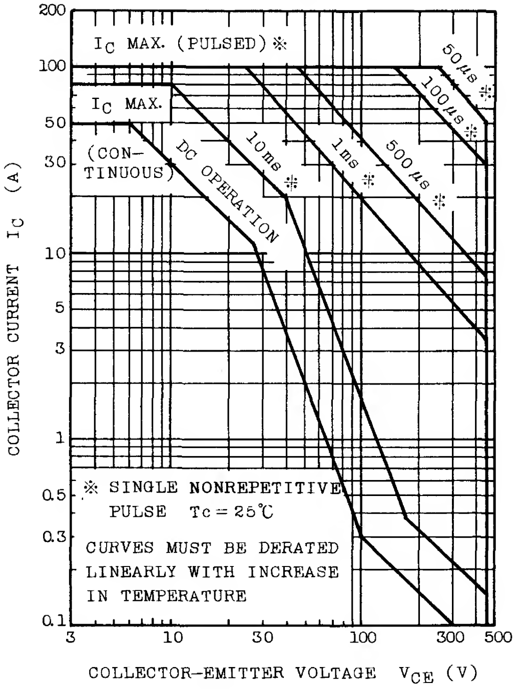

hFE − IC
COMMON EMITTER
VCE = 5V
DC CURRENT GAIN hFE
3000
1000
500
300
100
50
30
0.5
1
3
10
30
100
COLLECTOR CURRENT IC (A)
Tc = 100°C
25
−40



$V_{BE(sat)}$ − I_C



SWITCHING CHARACTERISTIC



SAFE OPERATING AREA

SILICON NPN TRIPLE DIFFUSED TYPE

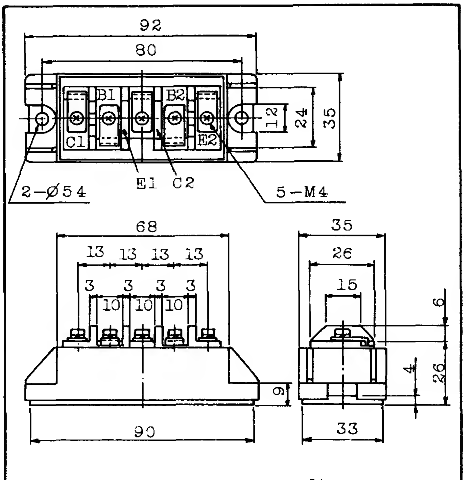
MG50G2CL3

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- 2 Power Transistors and 2 Free Wheeling Diods are Built-in to 1 Package.
- High DC Current Gain : h_{FE}=100(Min.) (I_C=50A)
- Low Saturation Voltage: $V_{CE(sat)}$=2V(Max.)(I_C=50A)
- High Speed : t_f=2μs(Max.) (I_C=50A)

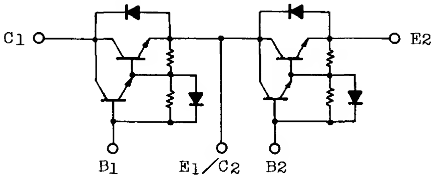
Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2−68A1A

Weight : 210g

EQUIVALENT CIRCUIT

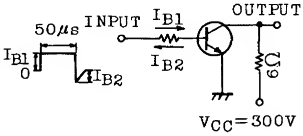


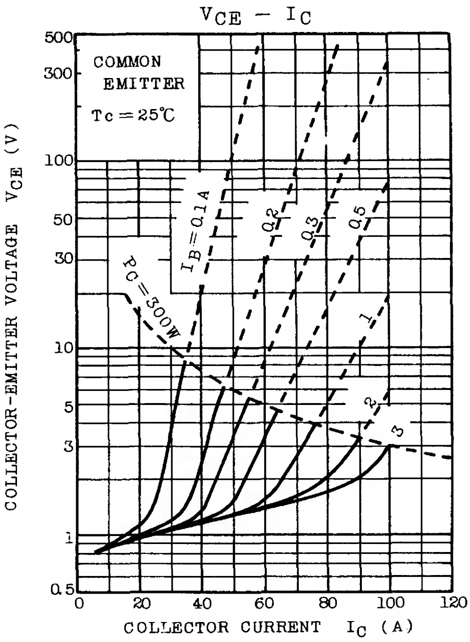
MAXIMUM RATINGS (Ta=25°C)

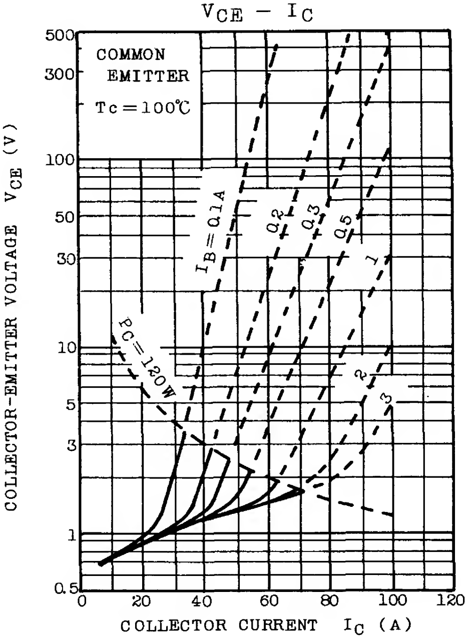
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		V_{CEO}	600	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	50	A
	1ms	I_C	100	A
	DC	$-I_C$	50	A
Base Current		I_B	3	A
Collector Power Dissipation (Tc=25°C)		P_C	300	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	−40～125	°C
Isolation Voltage		V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque (Terminal/Mounting)			20/30	kg·cm

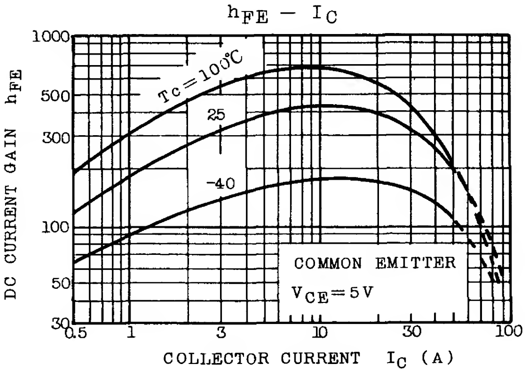
MG50G2CL3

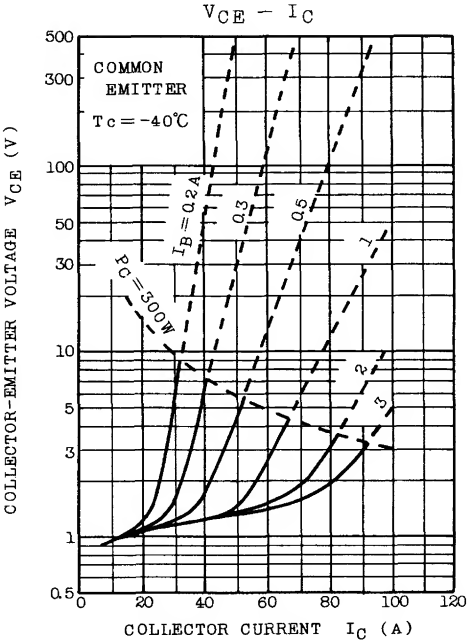
ELECTRICAL CHARACTERISTICS (Ta=25°C)

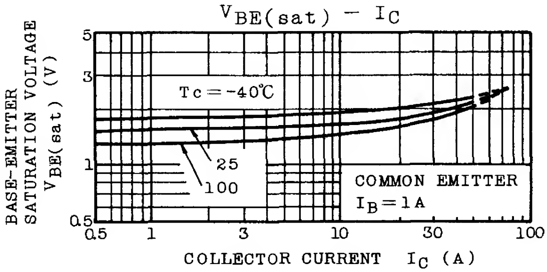
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V$, $I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V$, $I_C=0$	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=50A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=50A$, $I_B=1A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=50A$, $I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=50A$, $V_{EB}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	520	-	pF
Switching Time	Turn-on Time	t_{on}	 50μs INPUT I_{B1} OUTPUT I_{B1} 0 I_{B2} I_{B2} 6Ω $V_{CC}=300V$ $I_{B1}=-I_{B2}=1A$ DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.41	°C/W
			Diode	-	-	1.3	


$V_{CE} - I_C$
COMMON EMITTER
Tc = 25℃
I_B = 0.1 A
0.2
0.3
0.5
1
2
3
PC = 300W
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)

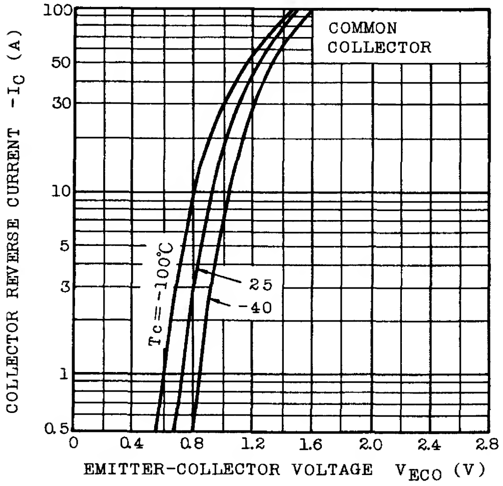

$V_{CE} - I_C$
COMMON EMITTER
Tc = 100℃
I_B = 0.1 A
0.2
0.3
0.5
1
2
3
PC = 120W
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)


$h_{FE} - I_C$
Tc = 100℃
25
-40
COMMON EMITTER
V_{CE} = 5 V
1000
500
300
100
50
30
0.5
1
3
10
30
100
DC CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C (A)

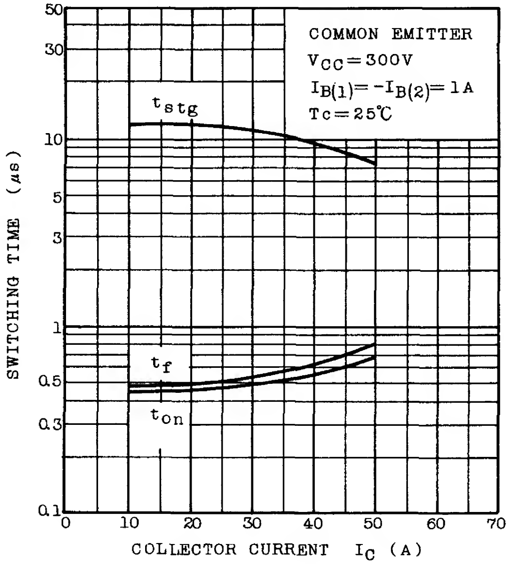

$V_{CE} - I_C$
COMMON EMITTER
Tc = -40℃
I_B = 0.2 A
0.3
0.5
1
2
3
PC = 300W
500
300
100
50
30
10
5
3
1
0.5
0
20
40
60
80
100
120
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)
COLLECTOR CURRENT I_C (A)


$V_{BE(sat)} - I_C$
Tc = -40℃
25
100
COMMON EMITTER
I_B = 1 A
5
3
1
0.5
0.5
1
3
10
30
100
BASE-EMITTER SATURATION VOLTAGE $V_{BE(sat)}$ (V)
COLLECTOR CURRENT I_C (A)

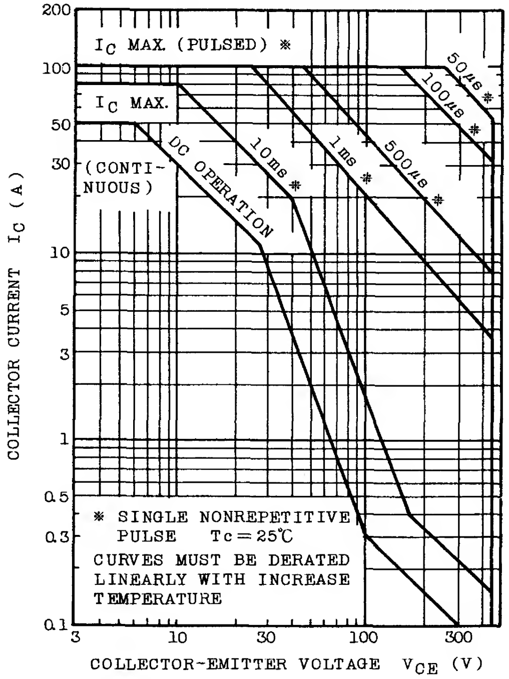
$-I_C - V_{ECO}$



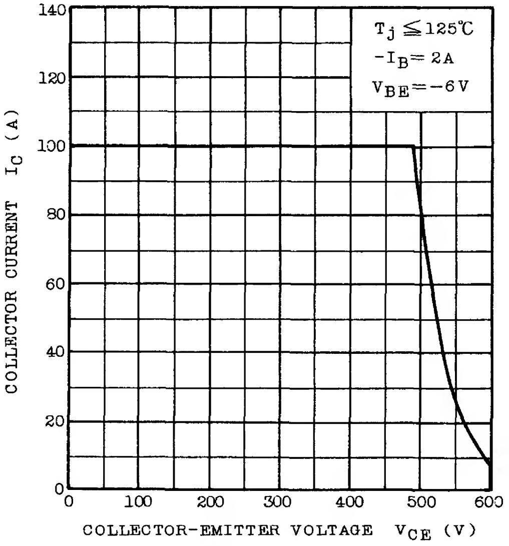
SWITCHING TIME – I_C



SAFE OPERATING AREA



REVERSE BIAS ASO



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

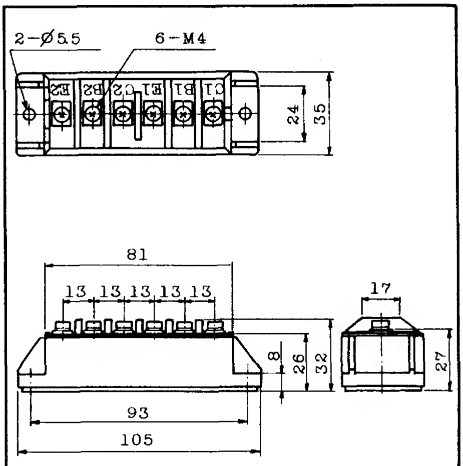
MG75H2DL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- 2 Power Transistors and 2 Free Wheeling Diodes are Built-in to 1 Package.
- High DC Current Gain : h_{FE}=80(Min.)(I_C=75A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.)(I_C=75A)
- High Speed : t_f=4μs(Max.)(I_C=75A)

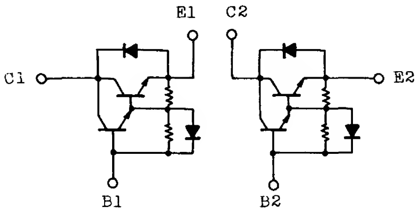
Unit in mm



JEDEC	−
EIAJ	−
TOSHIBA	2−81A1A

Weight :

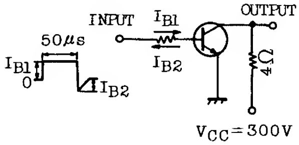
EQUIVALENT CIRCUIT



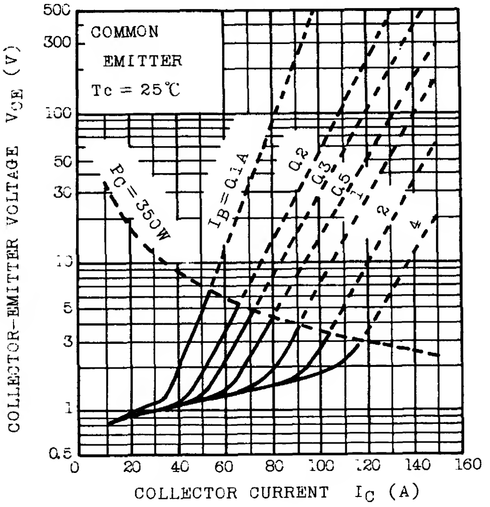
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	500	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	75	A
	1ms	I_{CP}	150	
	DC	$-I_C$	75	
Base Current		I_B	4	A
Colletor Power Dissipation (Tc=25°C)		P_C	350	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40～125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torque (Terminal/Mounting)			20/30	kg·cm

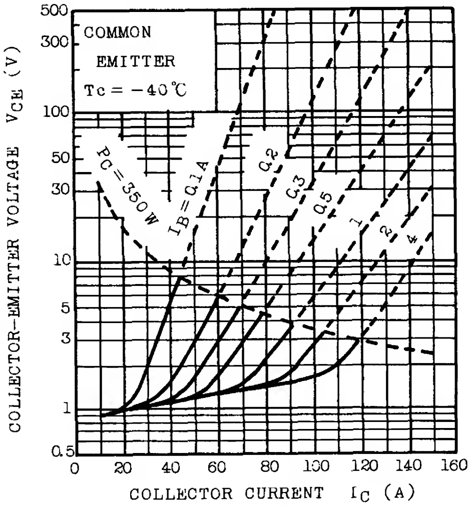
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	500	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=75A	80	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=75A, I_B=2A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	I_E=75A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=75A, V_{EB}=3V V_{CE}=300V	-	-	2.0	µs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0 f=1MHz	-	670	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT IB1 OUTPUT 50µs IB1 0 IB2 IB2 4Ω VCC=300V $I_{B1}=-I_{B2}$=2A DUTY CYCLE=0.5%	-	-	2.0	µs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	4.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.36	°C/W
			Diode	-	-	1.3	

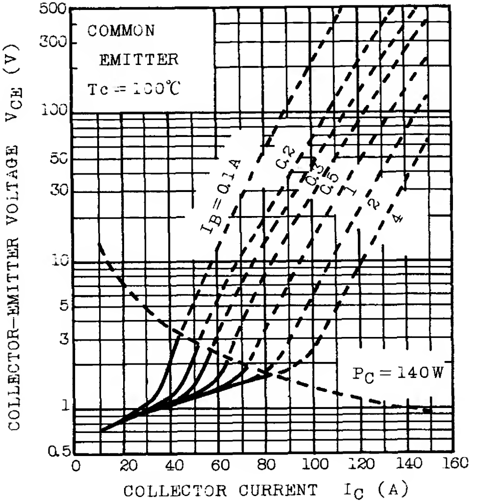
$V_{CE} - I_C$



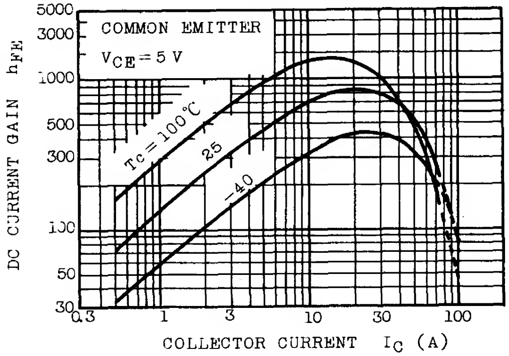
$V_{CE} - I_C$



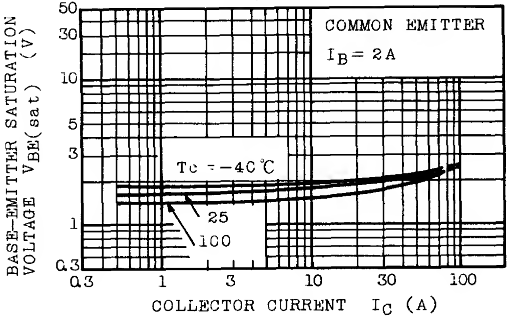
$V_{CE} - I_C$

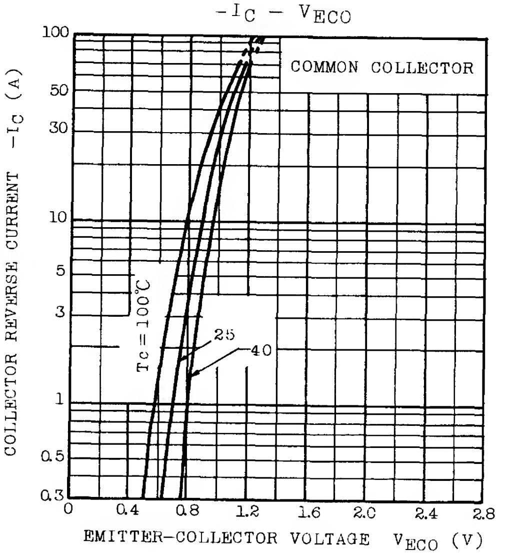


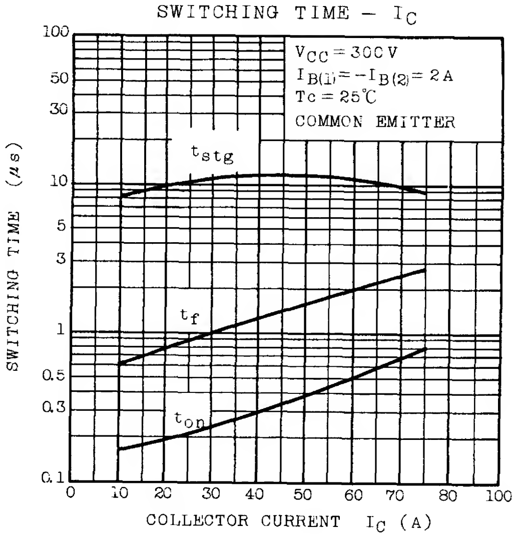
$h_{FE} - I_C$

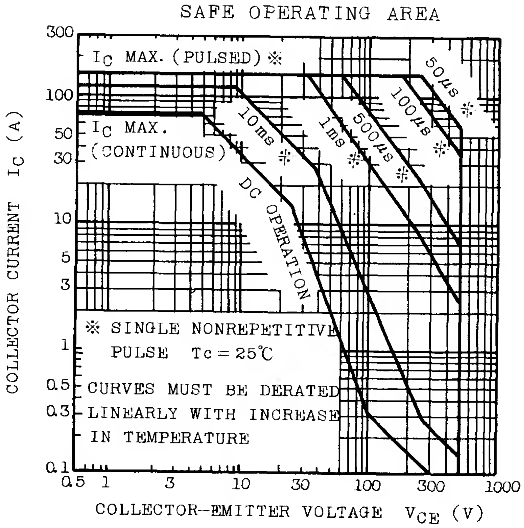


$V_{BE(sat)} - I_C$




$-I_C - V_{ECO}$
COMMON COLLECTOR
Tc = 100°C
25
40
100
50
30
10
5
3
1
0.5
0.3
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
COLLECTOR REVERSE CURRENT $-I_C$ (A)
EMITTER-COLLECTOR VOLTAGE V_{ECO} (V)


SWITCHING TIME – I_C
V_{CC} = 300 V
$I_{B(1)} = -I_{B(2)}$ = 2 A
Tc = 25°C
COMMON EMITTER
t_{stg}
t_f
t_{on}
100
50
30
10
5
3
1
0.5
0.3
0.1
0
10
20
30
40
50
60
70
80
100
SWITCHING TIME (μs)
COLLECTOR CURRENT I_C (A)


SAFE OPERATING AREA
I_C MAX. (PULSED) ※
I_C MAX. (CONTINUOUS)
50 μs ※
100 μs ※
500 μs ※
1 ms ※
10 ms ※
DC OPERATION
※ SINGLE NONREPETITIVE PULSE Tc = 25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
300
100
50
30
10
5
3
1
0.5
0.3
0.1
0.5
1
3
10
30
100
300
1000
COLLECTOR CURRENT I_C (A)
COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED TYPE

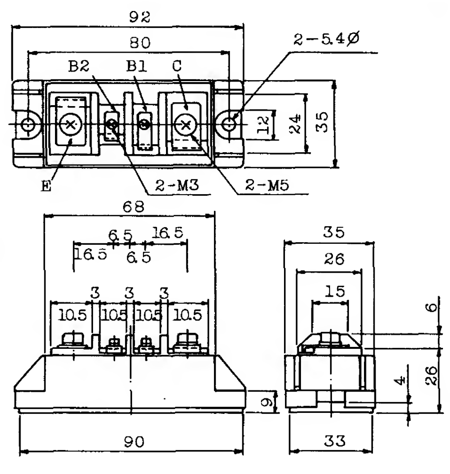
MG100G1FL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- With Built-in Free Wheeling Diode
- High DC Current Gain : h_{FE}=100(Min.) (I_C=100A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.)(I_C=100A)
- High Speed : t_f=2μs(Max.)(I_C=100A)

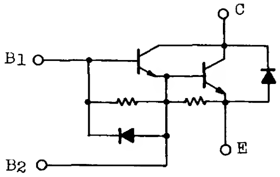
Unit in mm



JEDEC	—
EIAJ	—
TOSHIBA	2-68C1A

Weight : 210g

EQUIVALENT CIRCUIT

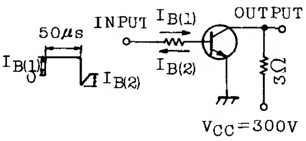


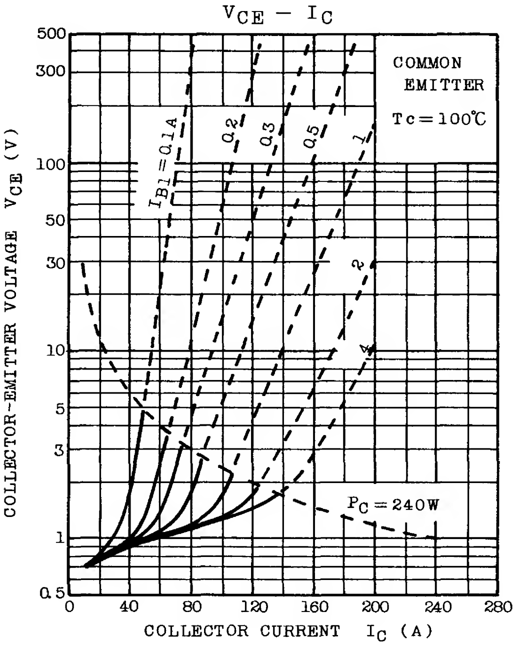
MAXIMUM RATINGS (Ta=25°C)

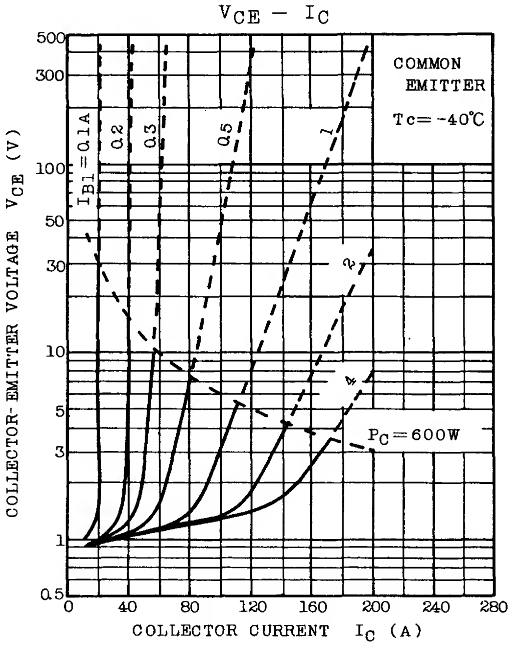
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB1O}	600	V
Collector-Emitter Voltage		V_{CEO}	600	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EB1O}	6	V
Collector Current	DC	I_C	100	A
	1ms	I_C	200	A
	DC	$-I_C$	100	A
Base Current		I_{B1}	5	A
Collector Power Dissipation (Tc=25°C)		P_C	600	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40~125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torque	Teminal (M3/M5)		10/30	kg·cm
	Mounting		30	

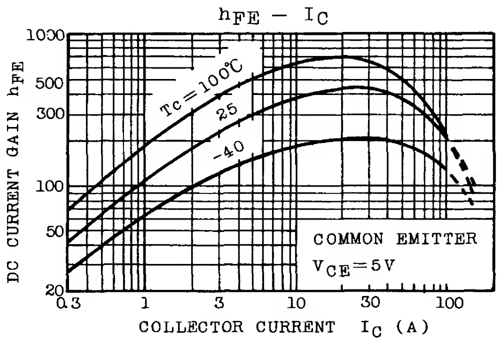
MG100G1FL1

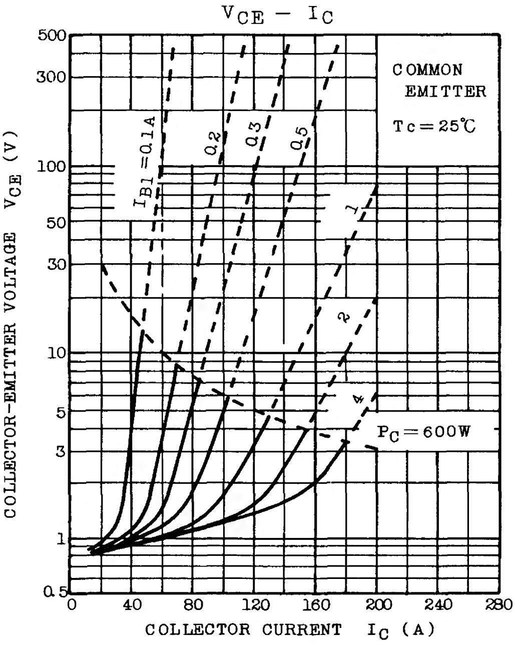
ELECTRICAL CHARACTERISTICS ($T_a=25°C$)

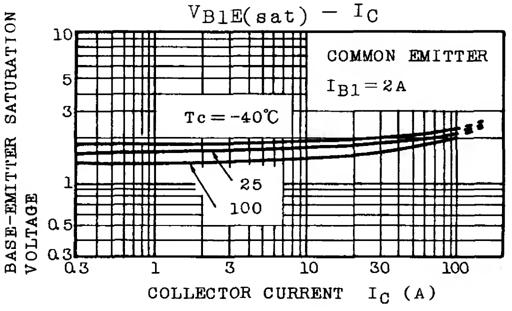
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB1O}	$V_{CB1}=600V$, $I_E=0$	-	-	2.0	mA
Emitter Cut-off Current		I_{EB1O}	$V_{EB1}=6V$, $I_C=0$	-	-	400	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=100A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100A$, $I_{B1}=2A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{B1E(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=100A$, $I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=100A$, $V_{EB1}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB1}=50V$, $I_E=0$, $f=1MHz$	-	1000	-	pF
Switching Time	Turn-on Time	t_{on}	 50μs INPUT $I_{B(1)}$ OUTPUT $I_{B(1)}$ 0 $I_{B(2)}$ $I_{B(2)}$ 3Ω $V_{CC}=300V$ $I_{B(1)}=-I_{B(2)}=2A$ DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.208	°C/W
			Diode	-	-	0.65	


VCE – IC
COMMON EMITTER
Tc=100℃
IB1=0.1A
0.2
0.3
0.5
1
2
4
PC=240W
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
40
80
120
160
200
240
280
COLLECTOR CURRENT IC (A)

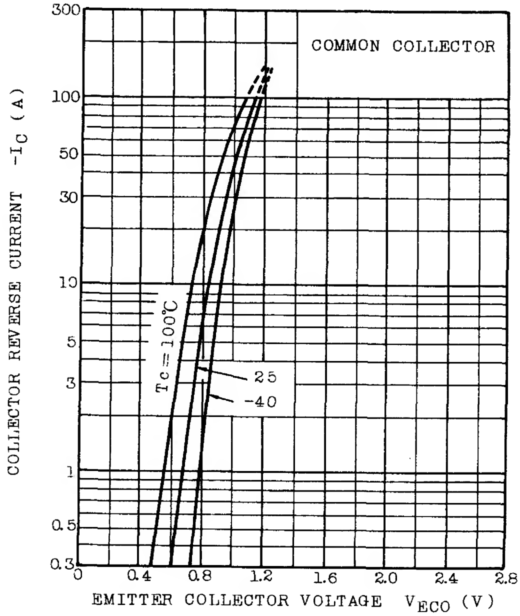

VCE – IC
COMMON EMITTER
Tc=-40℃
IB1=0.1A
0.2
0.3
0.5
1
2
4
PC=600W
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
40
80
120
160
200
240
280
COLLECTOR CURRENT IC (A)


hFE – IC
COMMON EMITTER
VCE=5V
Tc=100℃
25
-40
DC CURRENT GAIN hFE
1000
500
300
100
50
20
0.3
1
3
10
30
100
COLLECTOR CURRENT IC (A)

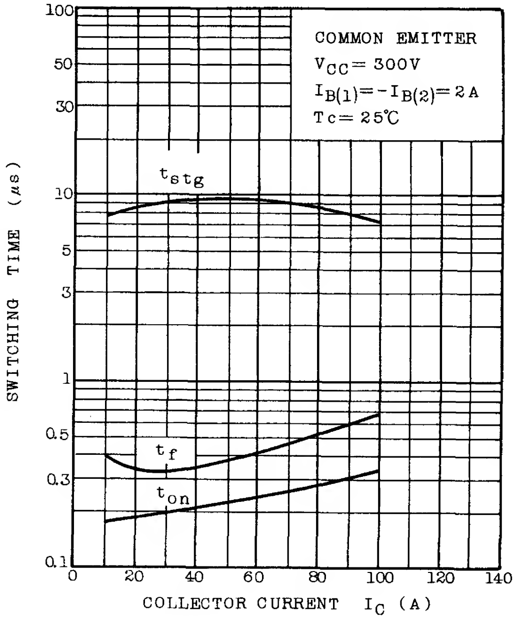

VCE – IC
COMMON EMITTER
Tc=25℃
IB1=0.1A
0.2
0.3
0.5
1
2
4
PC=600W
COLLECTOR-EMITTER VOLTAGE VCE (V)
500
300
100
50
30
10
5
3
1
0.5
0
40
80
120
160
200
240
280
COLLECTOR CURRENT IC (A)


VB1E(sat) – IC
COMMON EMITTER
IB1=2A
Tc=-40℃
25
100
BASE-EMITTER SATURATION VOLTAGE
10
5
3
1
0.5
0.3
0.3
1
3
10
30
100
COLLECTOR CURRENT IC (A)

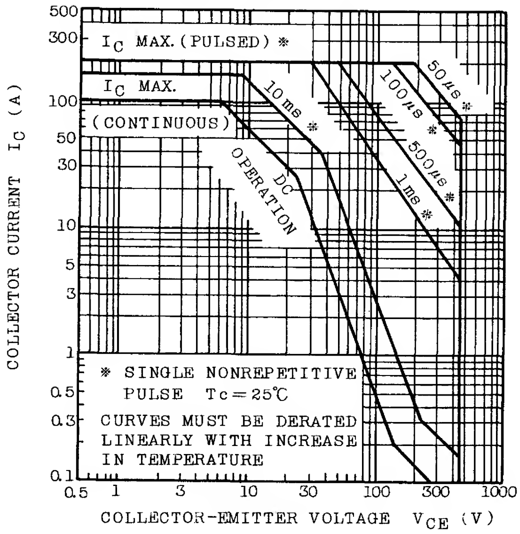
$-I_C - V_{ECO}$



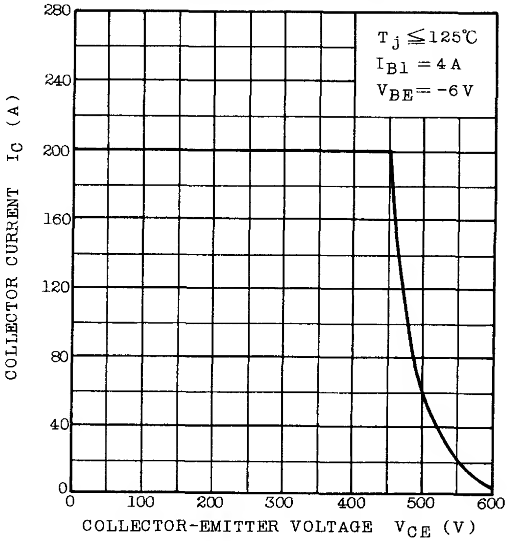
SWITCHING CHARACTERISTIC



SAFE OPERATING AREA



REVERSE BIAS ASO



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

MG100H1AL2

HIGH POWER SWITCHING APPLICATIONS.

MOTOR CONTROL APPLICATIONS.

FEATURES:

. The Collector is Isolated from Case.

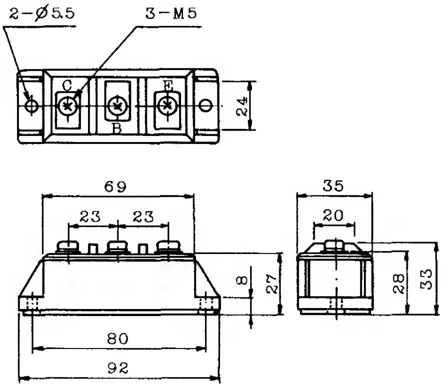
. With Built-in Free Wheeling Diode

. High DC Current Gain : h_{FE}=100(Min.)(I_C=100A)

. Low Saturation Voltage: $V_{CE(sat)}$=2V(Max.)(I_C=100A)

. High Speed : t_f=2μs(Max.)(I_C=100A)

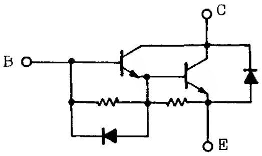
Unit in mm



JEDEC	−
EIAJ	−
TOSHIBA	2−69B1A

Weight : 227g

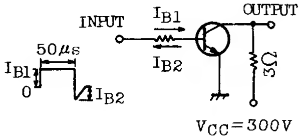
EQUIVALENT CIRCUIT



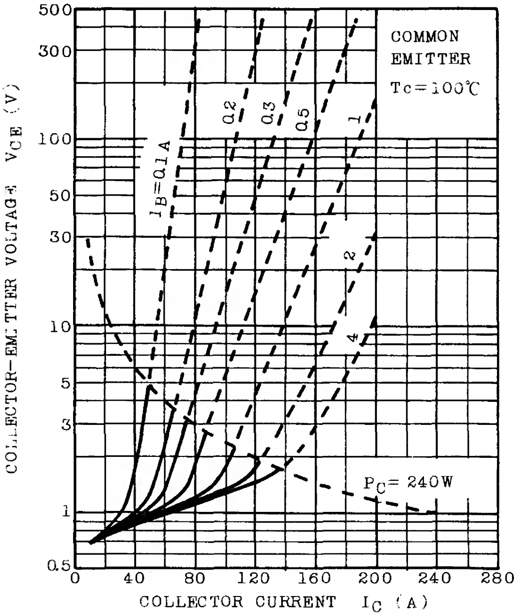
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	100	A
	1ms	I_{CP}	200	A
	DC	$-I_C$	100	A
Base Current		I_B	5	A
Collector Power Dissipation (Tc=25°C)		P_C	600	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40～125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torque			30	kg·cm

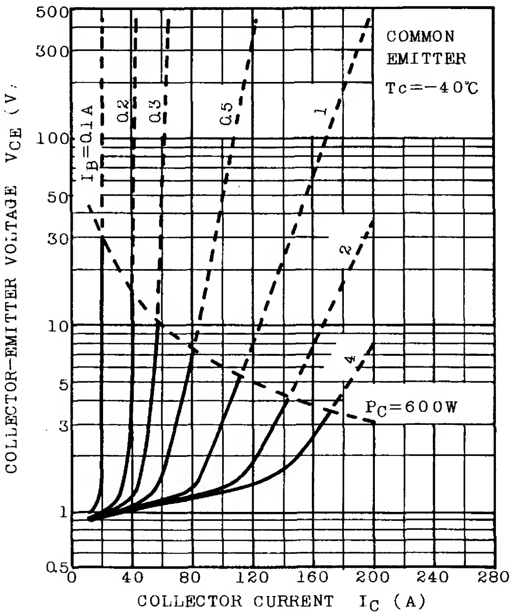
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	2.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	400	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	450	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=100A	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=100A, I_B=2A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	I_E=100A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=100A, V_{EB}=3V V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0 f=1MHz	-	1000	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT I_{B1} OUTPUT 50μs I_{B1} 0 I_{B2} I_{B2} 3Ω V_{CC}=300V $I_{B1}=-I_{B2}$=2A DUTY CYCLE=0.5%	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.208	°C/W
			Diode	-	-	0.65	

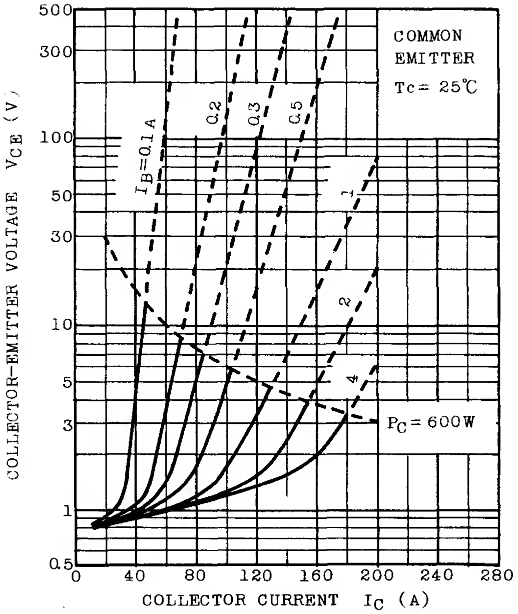
$V_{CE} - I_C$



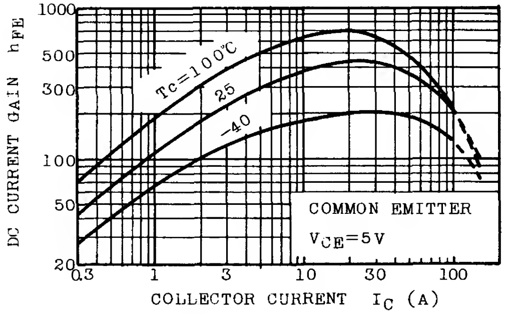
$V_{CE} - I_C$



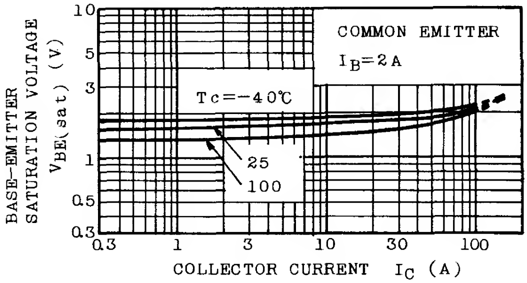
$V_{CE} - I_C$

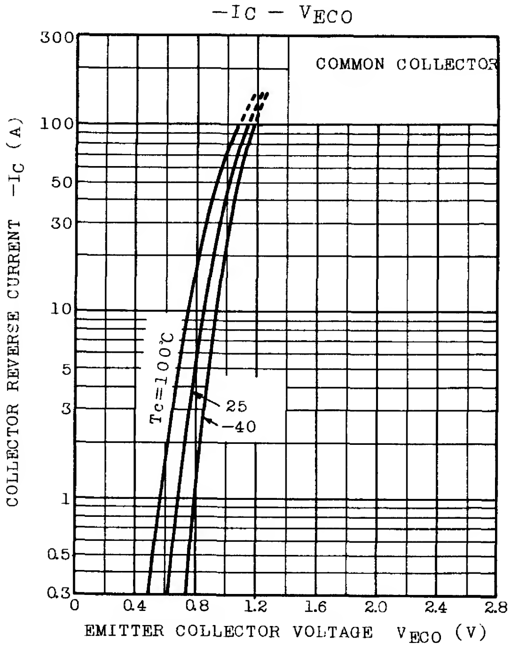


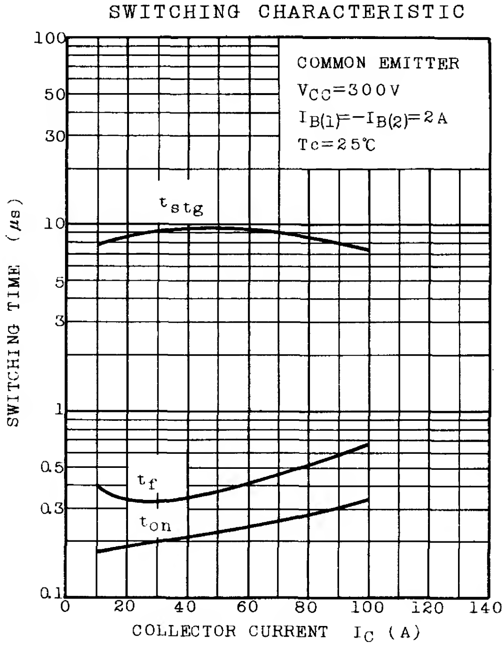
$h_{FE} - I_C$

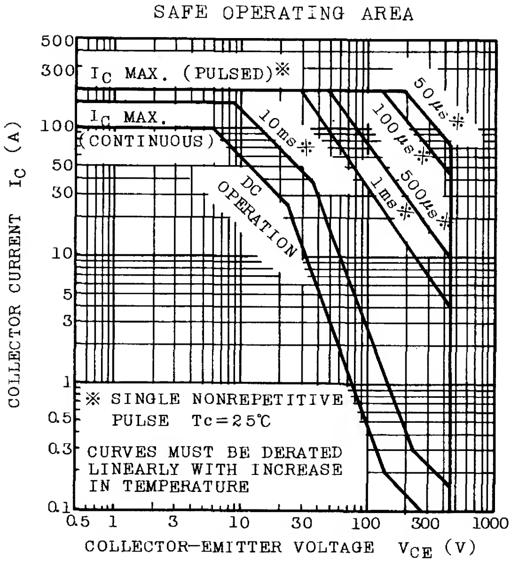


$V_{BE(sat)} - I_C$




$-I_C$ — V_{ECO}
COMMON COLLECTOR
T_c=100°C
25
−40
COLLECTOR REVERSE CURRENT $-I_C$ (A)
300
100
50
30
10
5
3
1
0.5
0.3
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
EMITTER COLLECTOR VOLTAGE V_{ECO} (V)


SWITCHING CHARACTERISTIC
COMMON EMITTER
V_{CC}=300V
$I_{B(1)}$=$-I_{B(2)}$=2A
Tc=25°C
t_{stg}
t_f
t_{on}
SWITCHING TIME (μs)
100
50
30
10
5
3
1
0.5
0.3
0.1
0
20
40
60
80
100
120
140
COLLECTOR CURRENT I_C (A)


SAFE OPERATING AREA
I_C MAX. (PULSED)※
I_C MAX. (CONTINUOUS)
50μs※
100μs※
500μs※
1ms※
10ms※
DC OPERATION
※ SINGLE NONREPETITIVE PULSE Tc=25°C
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT I_C (A)
500
300
100
50
30
10
5
3
1
0.5
0.3
0.1
0.5
1
3
10
30
100
300
1000
COLLECTOR—EMITTER VOLTAGE V_{CE} (V)

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

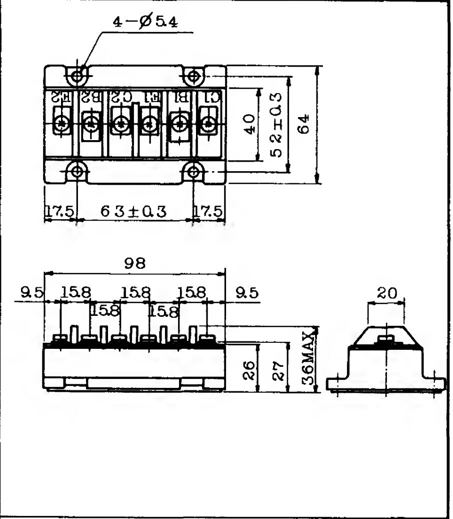
MG100H2DL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- With Built-in Free Wheeling Diode
- High DC Current Gain : h_{FE}=80(Min.)(I_C=100A)
- Low Saturation Voltage : $V_{CE(sat)}$=2V(Max.)(I_C=100A)
- High Speed : t_f=4μs(Max.)(I_C=100A)

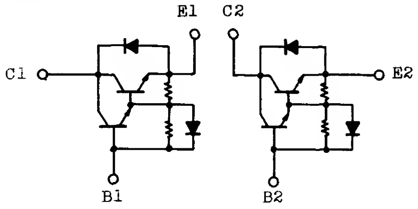
Unit in mm



JEDEC	−
EIAJ	−
TOSHIBA	2−98A1A

Weight :

EQUIVALENT CIRCUIT

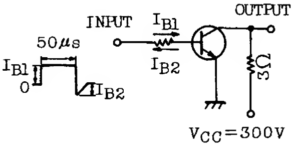


MAXIMUM RATINGS (T_a=25°C)

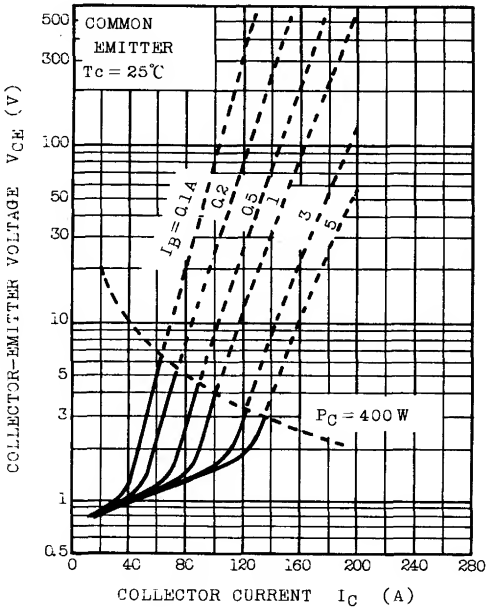
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	550	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	100	A
	1ms	I_{CP}	200	
	DC	$-I_C$	100	
Base Current		I_B	5	A
Collector Power Dissipation (Tc=25°C)		P_C	400	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40~125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torque			30	kg·cm

MG100H2DL1

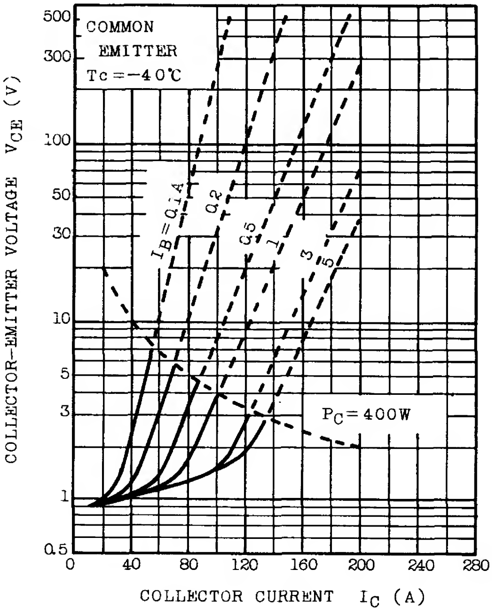
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	2.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	550	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=100A	80	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=100A, I_B=3A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.7	V
Emitter-Collector Voltage		V_{ECO}	I_E=100A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=100A, V_{EB}=3V V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0 f=1MHz	-	800	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT I_{B1} I_{B2} 50μs I_{B1} 0 I_{B2} 3Ω V_{CC}=300V $I_{B1}=-I_{B2}$=3A DUTY CYCLE=0.5%	-	-	2.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	4.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.31	°C/W
			Diode	-	-	1.3	

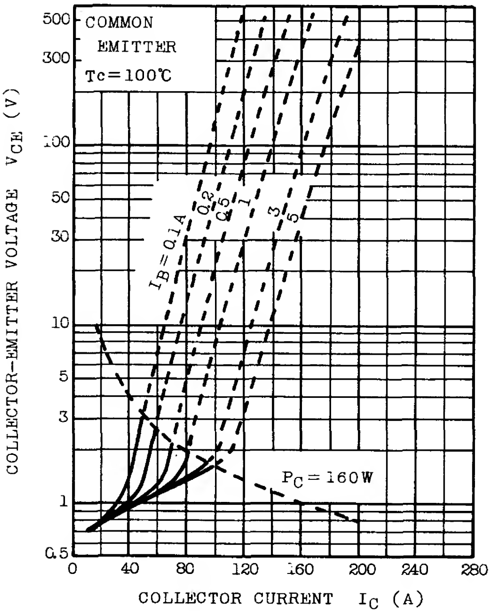
$V_{CE} - I_C$



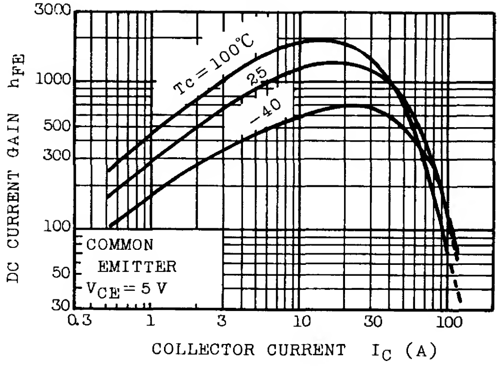
$V_{CE} - I_C$

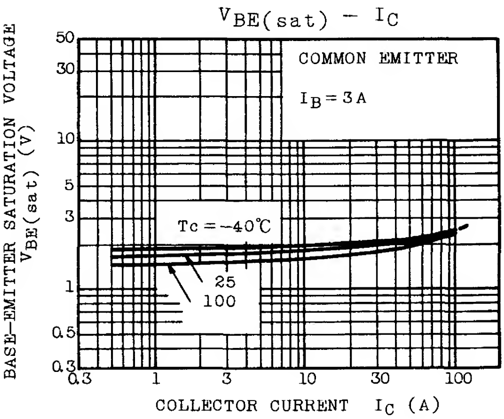


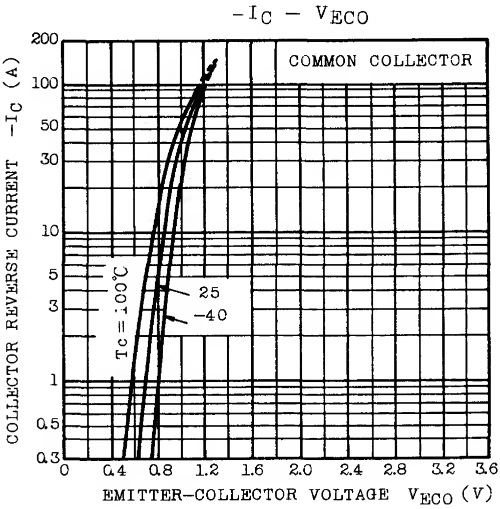
$V_{CE} - I_C$

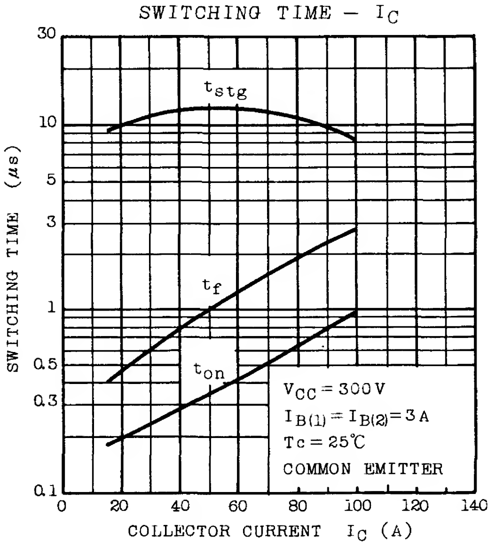


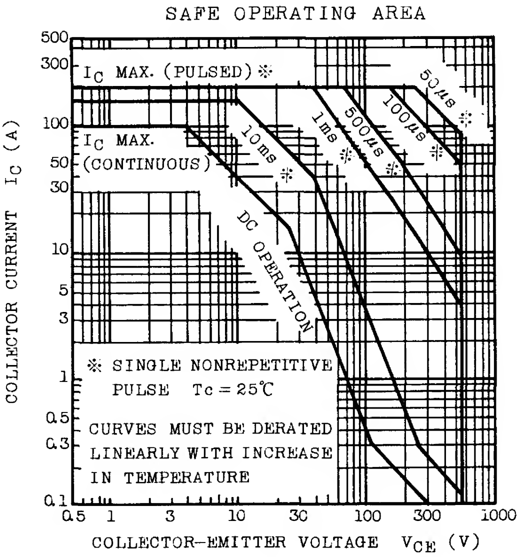
$h_{FE} - I_C$




VBE(sat) − IC
COMMON EMITTER
IB = 3 A
Tc = −40℃
25
100
BASE−EMITTER SATURATION VOLTAGE VBE(sat) (V)
50
30
10
5
3
1
0.5
0.3
0.3
1
3
10
30
100
COLLECTOR CURRENT IC (A)


−IC − VECO
COMMON COLLECTOR
Tc = 100℃
25
−40
COLLECTOR REVERSE CURRENT −IC (A)
200
100
50
30
10
5
3
1
0.5
0.3
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
EMITTER−COLLECTOR VOLTAGE VECO (V)


SWITCHING TIME − IC
tstg
tf
ton
VCC = 300 V
IB(1) = IB(2) = 3 A
Tc = 25℃
COMMON EMITTER
SWITCHING TIME (μs)
30
10
5
3
1
0.5
0.3
0.1
0
20
40
60
80
100
120
140
COLLECTOR CURRENT IC (A)


SAFE OPERATING AREA
IC MAX. (PULSED) ※
IC MAX. (CONTINUOUS)
50μs ※
100μs ※
500μs ※
1ms ※
10ms ※
DC OPERATION
※ SINGLE NONREPETITIVE PULSE Tc = 25℃
CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE
COLLECTOR CURRENT IC (A)
500
300
100
50
30
10
5
3
1
0.5
0.3
0.1
0.5
1
3
10
30
100
300
1000
COLLECTOR−EMITTER VOLTAGE VCE (V)

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

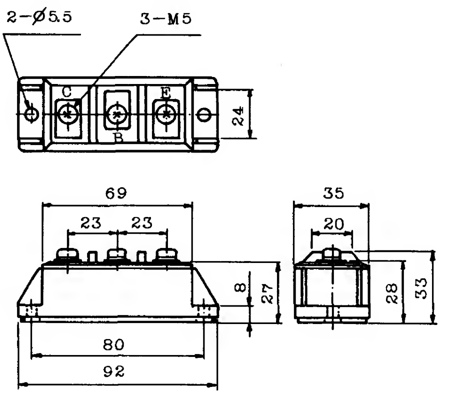
MG200H1AL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- The Collector is Isolated from Case.
- With Built-in Free Wheeling Diode
- High DC Current Gain : h_{FE}=80(Min.) (I_C=200A)
- Low Saturation Voltage: $V_{CE(sat)}$=2V(Max.)(I_C=200A)
- High Speed : t_f=4μs(Max.)(I_C=200A)

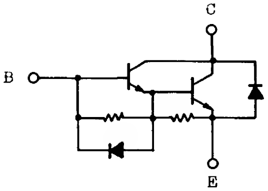
Unit in mm



JEDEC	−
EIAJ	−
TOSHIBA	2−69B1A

Weight : 227g

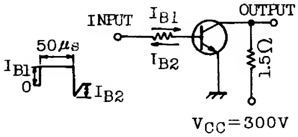
EQUIVALENT CIRCUIT



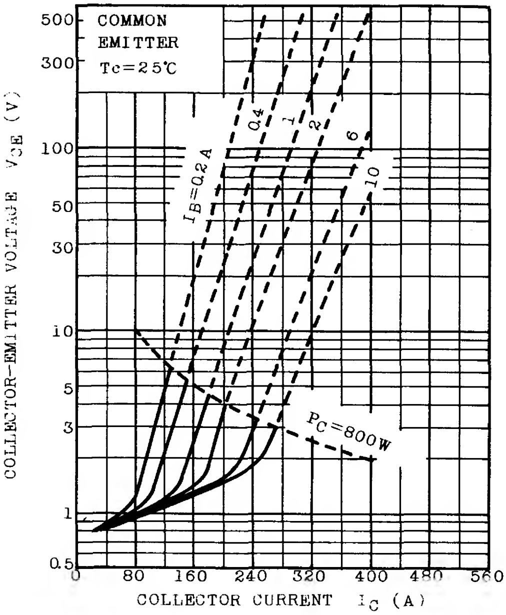
MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(SUS)}$	550	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	200	A
	Pulse	I_{CP}	400	A
	DC	$-I_C$	200	A
Base Current		I_B	8	A
Collector Power Dissipation (T_c=25°C)		P_C	800	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-40～125	°C
Isolation Voltage		V_{Isol}	2000(AC 1 Minute)	V
Screw Torque		-	30	kg·cm

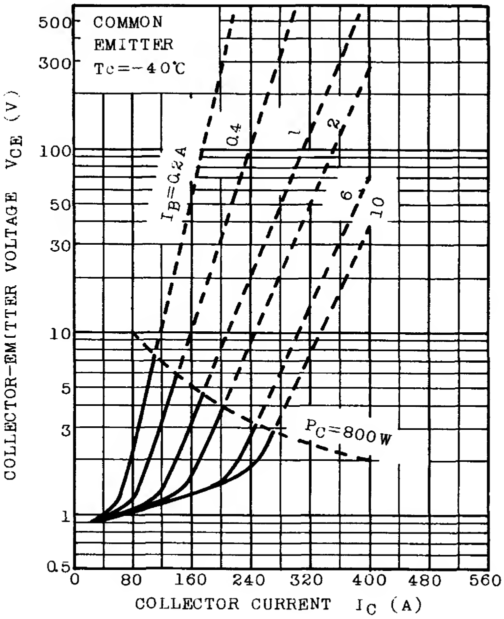
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=600V, I_E=0	-	-	2.0	mA
Emitter Cut-off Current		I_{EBO}	V_{EB}=6V, I_C=0	-	-	400	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	I_C=0.5A, L=40mH	550	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=200A	80	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=200A, I_B=6A	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.7	V
Emitter-Collector Voltage		V_{ECO}	I_E=200A, I_B=0	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C$=200A, V_{EB}=3V V_{CE}=300V	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	V_{CB}=50V, I_E=0 f=1MHz	-	1650	-	pF
Switching Time	Turn-on Time	t_{on}	 INPUT OUTPUT I_{B1} I_{B2} 50μs I_{B1} 0 I_{B2} 1.5Ω V_{CC}=300V $I_{B1}=-I_{B2}$=6 A DUTY CYCLE=0.5%	-	-	2.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	4.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.156	°C/W
			Diode	-	-	0.65	

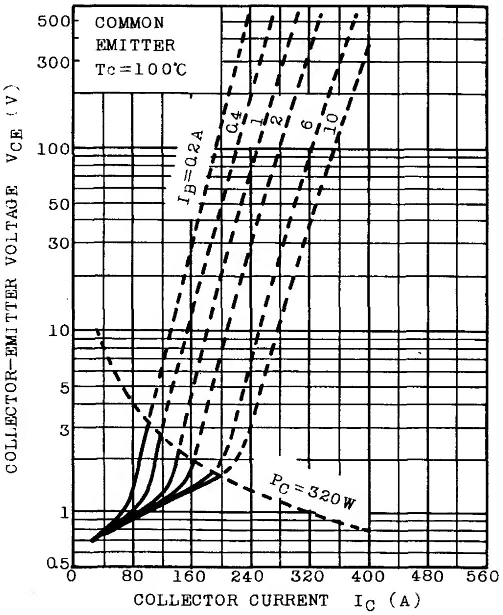
V_{CE} – I_C



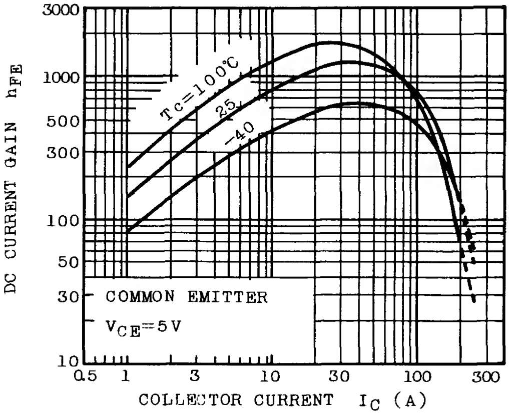
V_{CE} – I_C

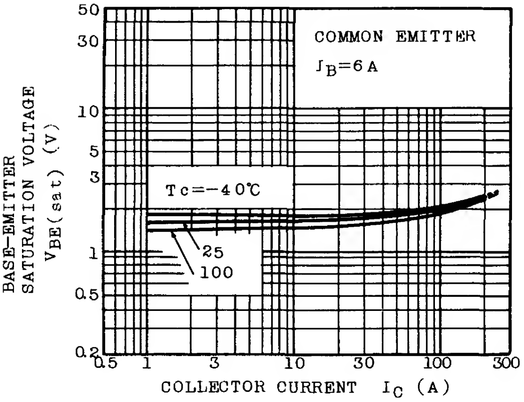


V_{CE} – I_C

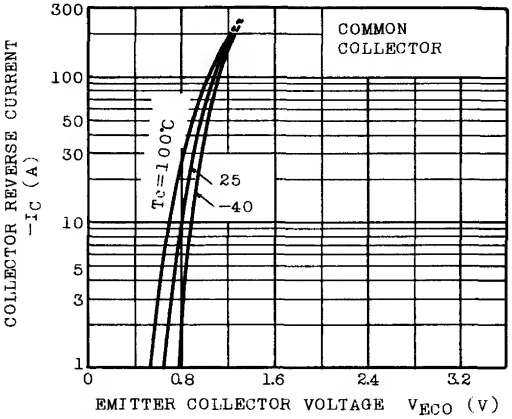


h_{FE} – I_C

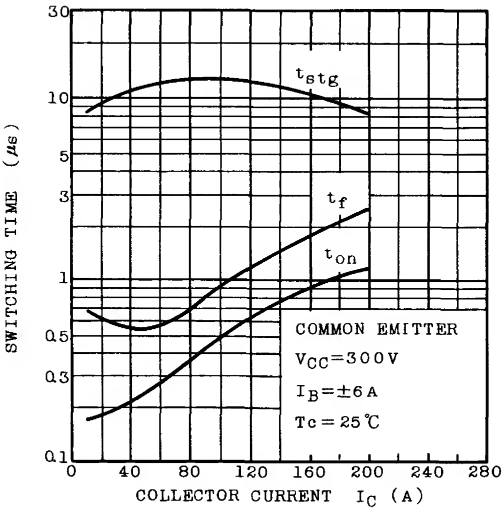




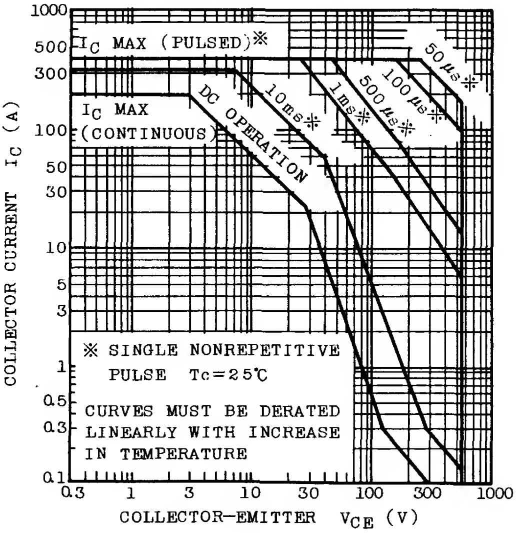
$V_{BE(sat)} - I_C$



$-I_C - V_{ECO}$



SWITCHING CHARACTERISTIC



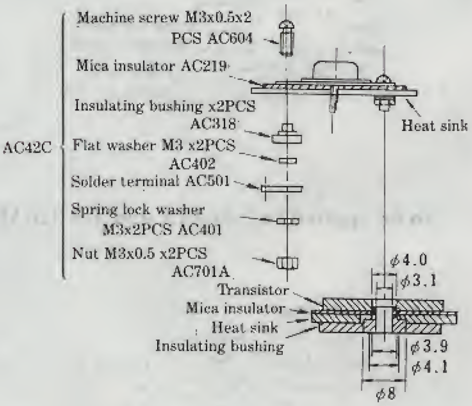
SAFE OPERATING AREA

ACCESSORIES

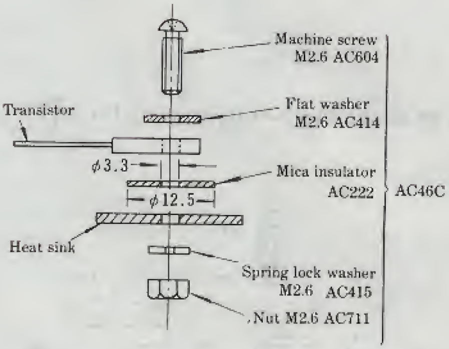
Accessories

Some semiconductors require accessories. Such accessories are listed below the external drawings of each semiconductor standard. Usage of such accessories is shown in the following figures.

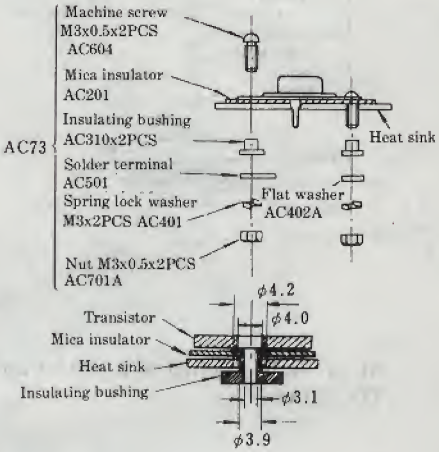
AC42C (to be applied to 2-21B1A and TO-3)



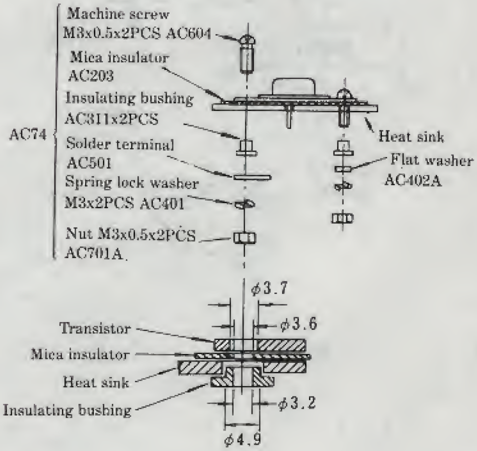
AC46C (to be applied to 2-8F1A)



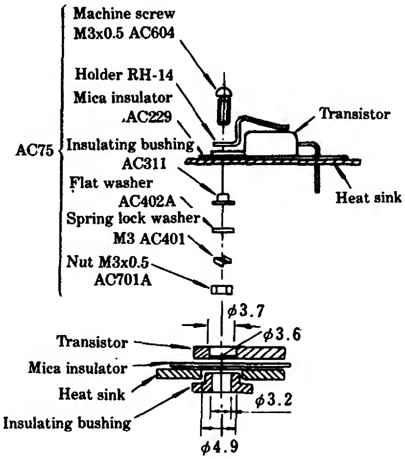
AC73 (to be applied to 2-21D1A, 21E1A, and TO-3)



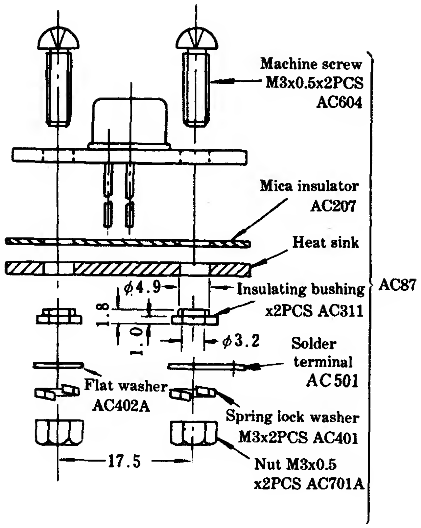
AC74 (to be applied to 2-13A1A and TO-66)



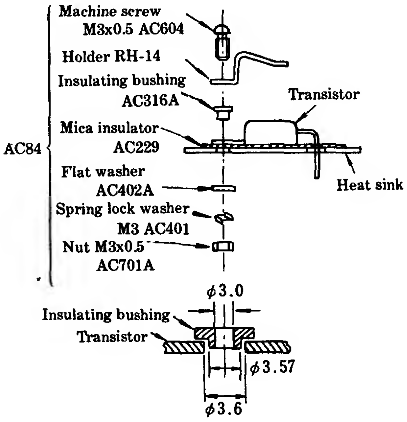
AC75 (to be applied to 2-10A1A and TO-220AB)



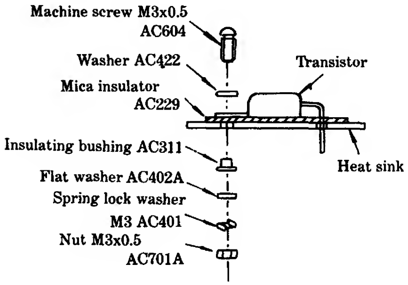
AC87 (to be applied to 2-9A1A)



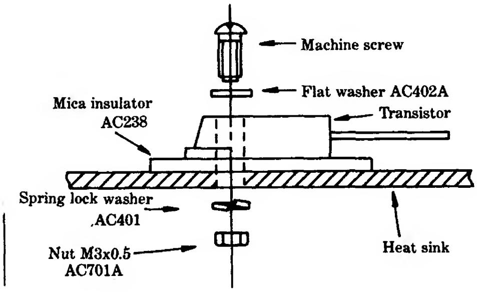
AC84 (to be applied to 2-10A1A and TO-220AB)



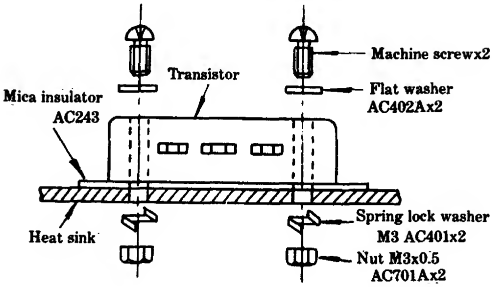
(to be applied to 2-10A1A and TO-220AB)



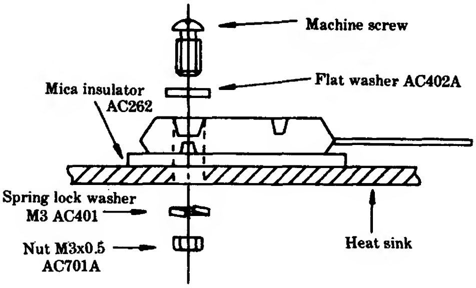
(to be applied to 2-16B1A and 2-16C1A)



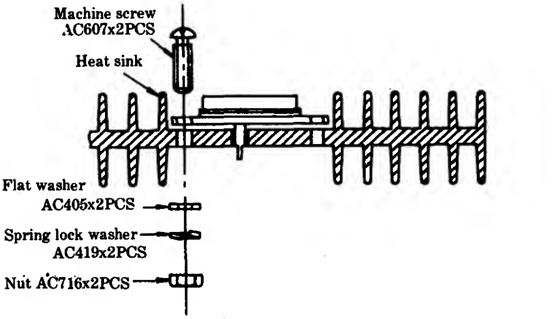
(to be applied to 2-34A1A)



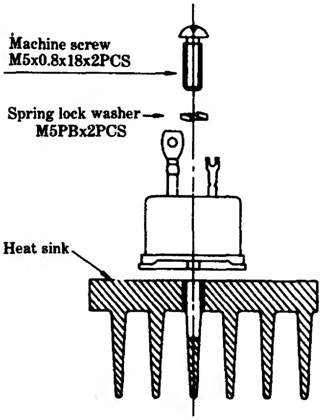
(to be applied to 2-21F1A)



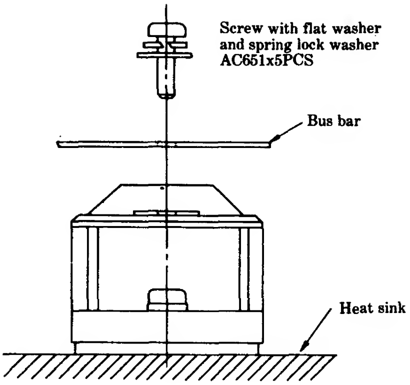
AC63 (to be applied to 2-33B1A)



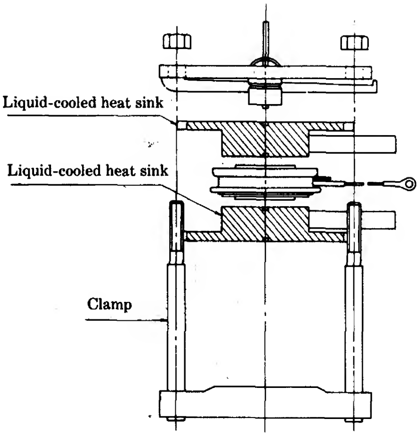
(to be applied to 2-31A1A)



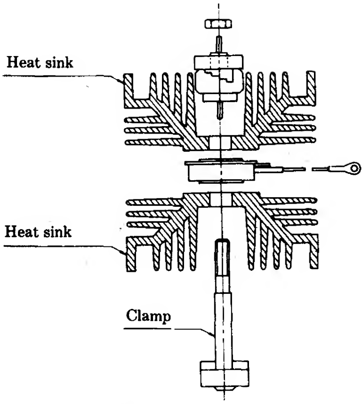
(to be applied to 2-69A1A)



(to be applied to 2-67A1A)



(to be applied to 2-67A1A)



Single-side clamp for G-Tr

1. Identification method

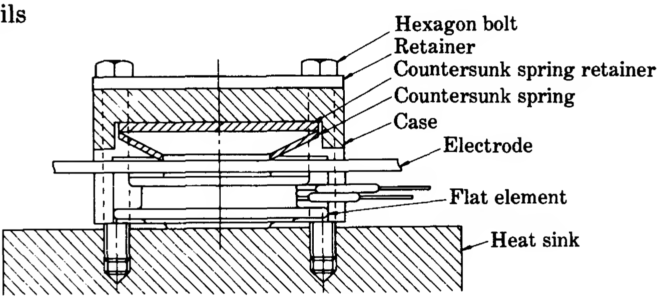
ASC650A

- A: Represents classification of kits
- 50: Represent contact pressure (50 for 500kg and 1k for 1000kg)
- 6: Represents maximum external shapes of flat elements to which to Toshiba flat-element, single-sided clamp can be applied (4 for ϕ45, 6 for ϕ60, 7 for ϕ67)
- ASC: Abbreviation for Accessory of Singleside Clamp

2. Applicable external shapes and accessory name

Applicable external shapes	2-42A1A	2-60B1A	2-67A1A
Model	ASC450A	ASC650A1	ASC71KA
Case	AC803	AC804	AC807
Retainer	AC425	AC426	AC435
Countersunk spring retainer	AC427	AC428	AC436
Countersunk spring	AC430×2	AC431	AC437
Electrode	AC506	AC507	AC507
Hexagon bolt	AC614×4	AC614×4	AC615×4

3. Mounting details



Mica Insulators

No.	Materials	Dimensions (mm)								Applicable transistors No.	Drawing
		φb	e	φd	g	s	U_1	U_2	t		
AC201	Mica	2.0	10.9	4.3	30.15	16.87	42.15	28.0	0.05~0.10	2-21D1A	1
AC203	〃	2.0	5.08	3.2	24.38	14.7	36.0	21.8	〃	2-13A1A	1
AC207	〃	0.75	5.08	3.3	17.5	—	27.4	14.7	〃	2-9A1A	2
AC219	〃	2.0	10.9	4.1	30.15	16.87	50.0	36.0	0.10~0.16	2-21B1A	1
AC222	〃	3.3	—	—	—	—	12.5	—	0.05~0.10	2-8F1A	3
AC226	〃	2.0	10.9	4.3	30.15	16.87	46.0	32.0	〃	2-21D1A	1
AC227	〃	5.0	19.0	5.2	43.3	25.0	58.0	40.0	〃	2-31B1A	1
AC229	〃	1.8	5.08	3.6	—	14.7	22.0	13.0	〃	2-10A1A	4
AC238	〃	—	—	3.3	—	16.0	22.0	18.5	〃	2-16B1A	5
AC240	〃	—	—	5.2	43.3	—	58.0	40.0	〃	2-31A1A	6
AC243	〃	—	—	3.3	24.4	—	38.0	20.0	〃	2-34A1A	7
AC246	〃	—	—	4.0	—	16.9	26.9	18.5	〃	2-16B1A	8
AC252	Silicone rubber	2.0	10.9	4.3	30.2	16.9	42.0	28.0	0.20~0.30	2-21D1A	1
AC253	〃	2.0	5.08	3.2	24.38	14.7	34.0	20.0	〃	2-13A1A	1
AC254	〃	—	—	3.6	—	13.8	17.8	12.9	〃	2-10A1A	5
AC255	〃	—	—	3.3	24.4	—	38.0	20.0	〃	2-34A1A	7
AC256	〃	—	—	3.3	—	16.0	22.0	18.5	〃	2-16B1A	5
AC261	Mica	—	—	3.3	—	24.0	34.0	28.0	0.15~0.25	2-21FIA	5
AC262	Mica	—	—	3.3	—	21.0	28.0	22.0	0.05~0.10	2-21FIA	5

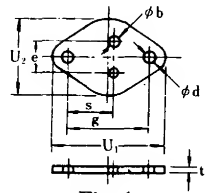


Fig. 1

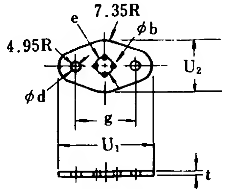


Fig. 2

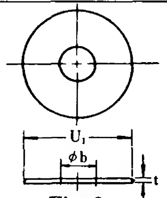


Fig. 3

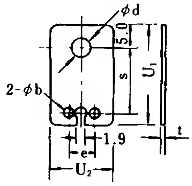


Fig. 4

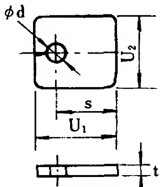


Fig. 5

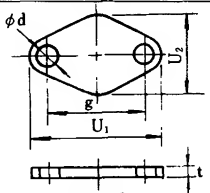


Fig. 6

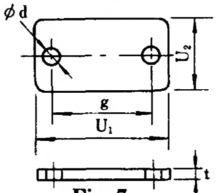


Fig. 7

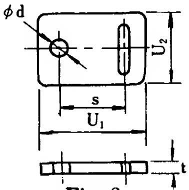


Fig. 8

Insulating Bushing

No.	Materials	Dimensions (mm)							Draw-ing
		ϕD_1	ϕD_2	ϕD_3	ϕD_4	H	h_1	h_2	
AC310	66 nylon	3.1	3.9	8.0	—	3.0	1.0	—	1
AC311	〃	3.2	4.9	8.0	—	1.8	1.0	—	1
AC316A	〃	3.0	3.57	5.3	—	1.5	0.5	—	1
AC318	〃	3.0	3.9	8.0	12	6.0	2.0	3.5	2
AC322	〃	4.2	5.0	9.0	—	5.5	2.0	—	1
AC331	Duranex	3.1	3.8	8.0	—	3.3	2.0	—	1
AC332	〃	4.2	5.0	9.0	—	7.5	2.0	—	1

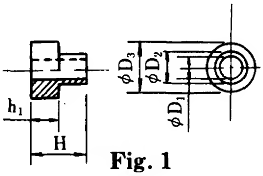


Fig. 1

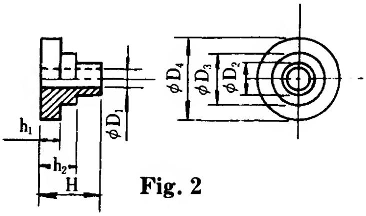


Fig. 2

Solder Terminal

No.	Materials	Dimensions (mm)									JIS naming	Draw-ing
		ϕb	ϕd	ϕD	E	F	G	K	h	t		
AC501	Nickel-plated brass	2.3	3.5	7.0	4.0	—	3.5	8.5	—	0.3	Similar to JIS C2803 Type ET	1
AC505	〃	—	4.3	8.0	5.0	5.0	4.0	10.0	5.0	0.5	—	2

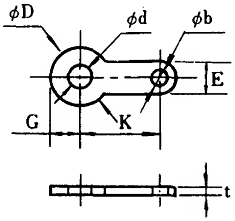


Fig. 1

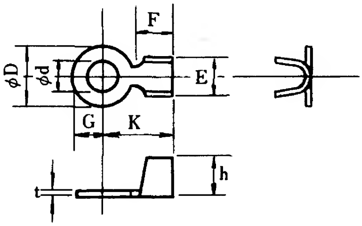


Fig. 2

Flat Washer

No.	Materials	Dimensions (mm)						JIS description	Drawing
		ϕd	ϕD	a	b	c	t		
AC402	Nickel-plated brass	3.3	8	—	—	—	0.5	JIS B1256 Small-sized, round, Class 1 M3BsP	1
AC402A	〃	3.3	6	—	—	—	0.5	JIS B1256 Square with a hole, Class 1 M3BsP	1
AC405	〃	5.5	12	—	—	—	0.8	JIS B1256 M5BsP	1
AC414	〃	2.9	5	—	—	—	0.5	JIS B1256 Square with a hole, Class 1 M2·6BsP	1
AC416	〃	4.3	9	—	—	—	0.8	JIS B1256 M4BsP	1
AC422	Nickel-plated soft copper	3.6	—	5.7	10.0	5.0	1.6	JIS G3101	2
AC424	Nickel-plated brass	5.3	7.3	—	—	—	0.8	JIS G3101 —	1

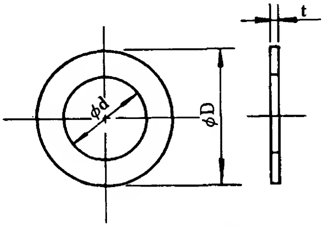


Fig. 1

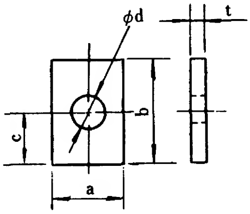
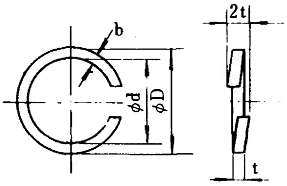


Fig. 2

Spring Lock Washer

No.	Materials	Dimensions (mm)			JIS naming
		ϕd	b × t	ϕD Max	
AC401	Nickel-plated phosphor bronze	3.1	1.1×0.7	5.9	JIS B1257 Spring lock washer No. 2 M3PB
AC415	Nickel-plated PHB	2.7	1.0×0.6	5.3	JIS B1251 Spring lock washer No. 2 M2.6PB
AC417	Nickel-plated brass	4.1	1.4×1.0	7.6	〃 M4PB
AC419	Nickel-plated phosphor bronze	5.1	1.7×1.3	8.5	〃 M5PB



Machine Screw

No.	Materials	Dimensions (mm)			JIS description	Drawing
		Nominal size × pitch	ℓ	S		
AC604	Nickel-plated brass	M3×0.5	12	11	JIS B1111+Cross-recessed head screw M3 × 0.5 × 12Bs	1
AC605	〃	M2.6×0.45	10	10	〃 M2.6 × 0.45 × 10Bs	
AC606	〃	M4 × 0.7	16	15	〃 M4 × 0.7 × 15Bs	
AC607	〃	M5 × 0.8	18	17	〃 M5 × 0.8 × 18Bs	
AC651	Iron and iron plating	—			〃	2

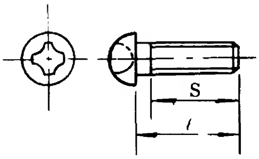


Fig. 1

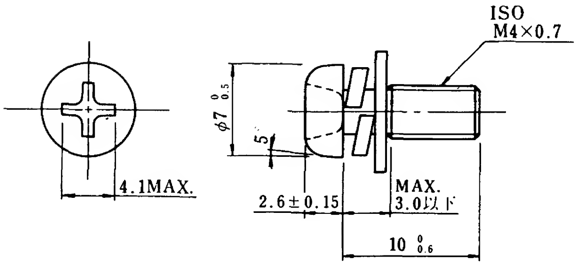
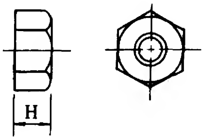


Fig. 2

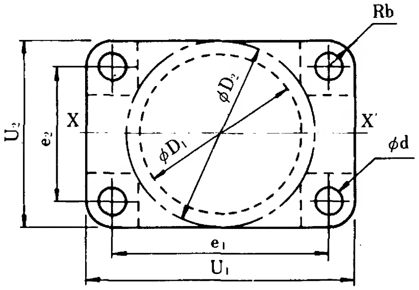
Nut

No.	Materials	Dimensions (mm)		JIS naming
		Nominal size x pitch	H	
AC701A	Nickel-plated brass	M5×0.5	2.4	JIS B1181 Hexagon nut Class 1A2 M3 × 0.5 × 12Bs
AC711	〃	M2.6×0.45	2.0	〃 M2.6 × 0.45Bs
AC714	〃	M4 × 0.7	3.2	〃 M4 × 0.7Bs
AC716	〃	M5×0.8	3.2	〃 M5 × 0.8Bs



Case

No.	Materials	Dimensions (mm)							Drawing
		U_1, U_2	H, W_1	W_2, D_1	D_2, b	d, e_1	e_2, h_1	h_2, h_3	
AC803	Premix	56 56	27.8 27	27 40.5	46 5	6.5 43	43 16	18 4.8	1
AC804	〃	66 60	26.8 32	32 56.5	60.3 6	6.5 54	48 14	18.2 3.6	1
AC807	〃	78 85	36.6 —	32 67.5	— 10	10.5 58	65 —	26 4.6	2



X-X' section

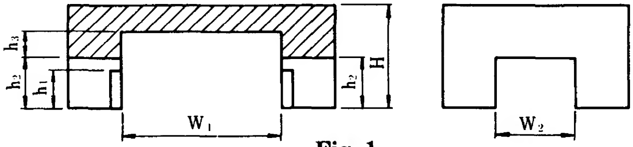


Fig. 1

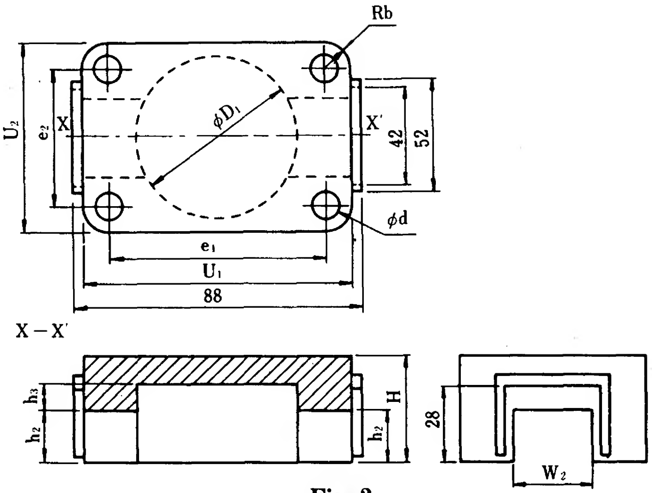


Fig. 2

Retainer

No.	Materials	Dimensions (mm)							Draw-ing
		U₁	U₂	t	b	d	e₁	e₂	
AC425	Iron-zinc chromate	56	56	4.5	5	6.5	43	43	1
AC426	〃	66	60	4.5	6	6.5	54	48	
AC435	〃	78	85	5.5	10	10.5	58	65	

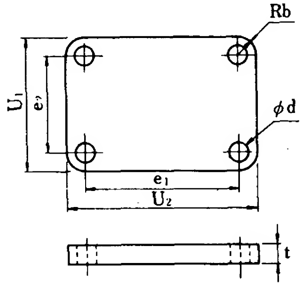


Fig. 1

Retainer

No.	Materials	Dimensions		Draw-ing
		D	t	
AC427	Iron-zinc chromate	40.4	2.5	2
AC428	〃	56.4	2.5	2
AC436	〃	67.5	2.5	2

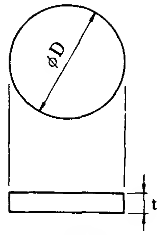
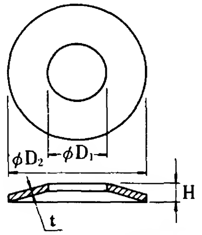


Fig. 2

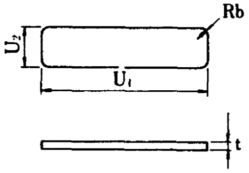
Countersunk spring

No.	Materials	Dimensions (mm)			
		D₁	D₂	H	t
AC430	Iron-zinc chromate	14	40	4.3	2.6
AC431	〃	20	56	4.1	1.8
AC437	〃	24	67	5.4	2.8



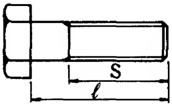
Electrode plate

No.	Materials	Dimensions (mm)			
		U₁	U₂	t	b
AC506	Nickel-plated copper	150	25	3	5
AC507	〃	150	30	3	5



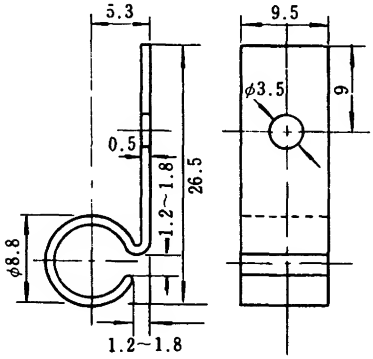
Hexagon bolt

No.	Materials	Dimensions (mm)			JIS description
		Nominal size × pitch	ℓ	S	
AC614	Iron-zinc chromate	M 6 ×1.0	50	48	JIS B1180 Hexagon
AC615	〃	M×1.5	50	48	〃



Radiator Holder

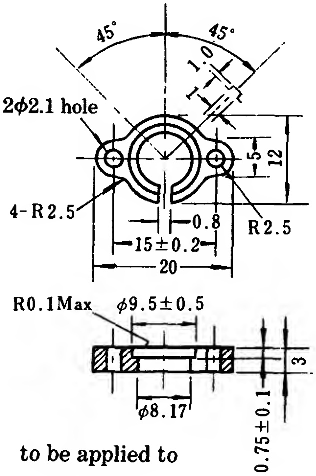
RH-2



to be applied to

JEDEC	TO−39
EIAJ	TC−5
TOSHIBA	TB−5B

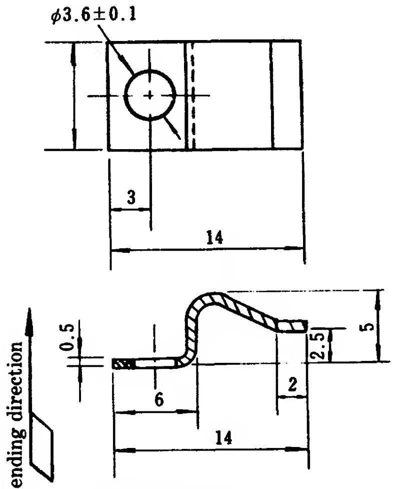
RH-10



to be applied to

JEDEC	TO−39
EIAJ	TC−5
TOSHIBA	TB−5B

RH-14



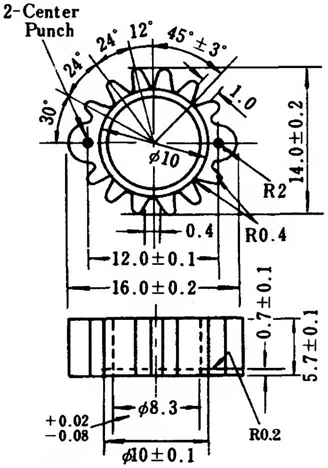
to be applied to

JEDEC TO-220AB

EIAJ SC-46

TOSHIBA 2-10A1A

RH-15



to be applied to

JEDEC	TO−39
EIAJ	TC−5
TOSHIBA	TB−5B

APPLICATION CIRCUIT

Radio

1. 9-transistor FM/AM radio circuit 1213
2. 10-transistor FM/AM radio circuit 1214
3. 6-transistor car radio circuit 1215
4. 5-transistor line operate radio circuit 1216

FM Stereo unit

1. FM tuner circuit (1) 1217
2. FM tuner circuit (2) 1218
3. FM electonic tuner 1218
4. Hi-Fi FM tuner 1219
5. Electronic tuning AM tuner (for Hi-Fi) 1219
6. Electronic tuning AM tuner (for automotive use) 1220
7. FM IF amplifier circuit 1220
8. FM multiplex circuit 1221

Audio amplifier circuit

1. Preamplifier circuit
   (1) MC head amplifier using 2SK 147 1222
2. Preamplifier circuit
   (2) First-stage equalizer amplifier using 2SK117 1222
3. Preamplifier circuit
   (3) First-stage equalizer amplifier using 25SK147 or 2SK146 1222
4. Preamplifier circuit
   (4) Ceramic crystal cartridge application 1223
5. Preamplifer circuit
   (5) CR-type tone control circuit 1223
6. Power amplifier circuit for 1.5W power 1224
7. Power amplifier circuit for 5W power 1224
8. Power amplifier circuit for 35 ~ 80W 1225
9. Power amplifier circuit for 120W power 1226
10. Power amplifier circuit for 120W power (using power MOS FET) 1226

Switching circuit

1. Inverter circuit (1) 1227
2. Inverter circuit (2) 1228
3. Monostable multivibrator circuit 1229

4. Astable multivibrator circuit 1229
5. Fixed bias-type flip-flop circuit 1230
6. Self-bias-type flip-flop circuit 1230
7. Schmidt circuit 1231
8. Positive pulse amplifier circuit 1231
9. Negative pulse amplifier circuit 1231
10. Indication tube driving circuit 1232
11. UJT application circuit 1233

Dropper Regulator Circuit

1. High-stability reference regulator circuit 1234
2. Constant-voltage regulator circusit
(1) 12V, 50mA 1234
3. Constant-voltage regulator circuit
(2) 12V, 1A 1234
4. Constant-voltage regulator circuit
(3) 24V, 1.5A 1234
5. Constant-voltage regulator circuit
(4) 24V, 2A 1235
6. Constant-voltage regulator circuit
(5) 0 ~ 30V, 1.5A 1235
7. Constant-voltage regulator circuit 1236
8. Multivibrator-type DC-DC converter circuit
(1) 50V, 3W (Vi = 12V) 1236
9. Multivibrator-type DC-DC converter circuit
(2) 300V, 40W (Vi = 12V) 1236
10. Multivibrator-type DC-DC converter circuit
(3) 300V, 40W (Vi = 24V) 1237
11. Multivibrator-type DC-DC converter circuit
(4) 300V, 80W (Vi = 24V) 1237
12. Multivibrator-type DC-DC convertercircuit
(5) 5V, 150W (Vi = 100V) 1238
13. Multivibrator-type DC-DC inverter circuit, 100V, 80W (Vi = 24V) 1238
14. Example circuit incorporating aringing choke circuit 1239
15. 20V, 2A Output dropper regulator, dropper regulator circuit 1239
16. 12V, 1A Output dropper regulator 1240
17. ±15V, 2A Output dropper regulator shown below is applied
incroporating transistor 2N3771 and 2N4398 1240

Circuit incroporating FET's

1. Amplifier circuit with direct-coupled FET, voltage gain 62dB, mim. sensing signal ~ 1mV 1241
2. FET differential amplifier circuit (1) Voltage gain 26dB 1241
3. FET differential amplifier circuit (3) Voltage gain 26dB 1241
4. FET differential amplifier circuit (2) Voltage gain 16dB 1241
5. FET2-stage differential amplifier circuit, voltage gain 34dB (openloop gain: 53dB) 1242
6. FET3-stage differential amplifier circuit, open loop gain 98 dB 1242
7. Digital switch 1243
8. Analog switch 1243
9. Sample hold circuit 1243
10. FET chopper amplifier circuit 1244
11. FET flip-flop circuit 1244
12. FET timer circuit (1) 1244
13. FET timer circuit (2), operating time: 10 min. 1244

Low-frequency amplifier circuit

1. RC coupled amplifier circuit 1245
2. Class A single amplifier circuit (1), Po = 55mA 1245
3. Class A single amplifier circuit (2), Po = 75mA 1245
4. Class B push-pull amplifier circuit (1), Po = 200mW 1246
5. Class B push-pull amplifier circuit (2), Po = 400mW 1246
6. Transformer-coupled Class A power amplifier circuit, Po = 5W (Vi = 0.4V) 1246
7. Transformer-coupled Class B power amplifier circuit, P = 7W (Vi = 0.6V) 1247
8. SEPP power amplifier circuit with imput tranformer, Po = 200W (Vi = 1.5V) 1247

High-frequency power amplifier circuit

1. Couble-multiplier power amplifier circuit (112.5 MHz ~ 450 MHz) 1248
2. Triple-multiplier 2-stage amplifier circuit (156.6 MHz ~ 470 MHz) 1248
3. Power amplifier circuit (175 MHz, FM 70W) 1249
4. Power amplifier circuit (470 MHz, FM 40W) 1249
5. Power amplifier circuit (430 ~ 450 MHz) 1249

Applied circuit of large-power transistor and transistor modules (motor drive circuit)

1. DC motor control (1) 1250
2. DC motor control (2) 1250
3. AC motor control 1250

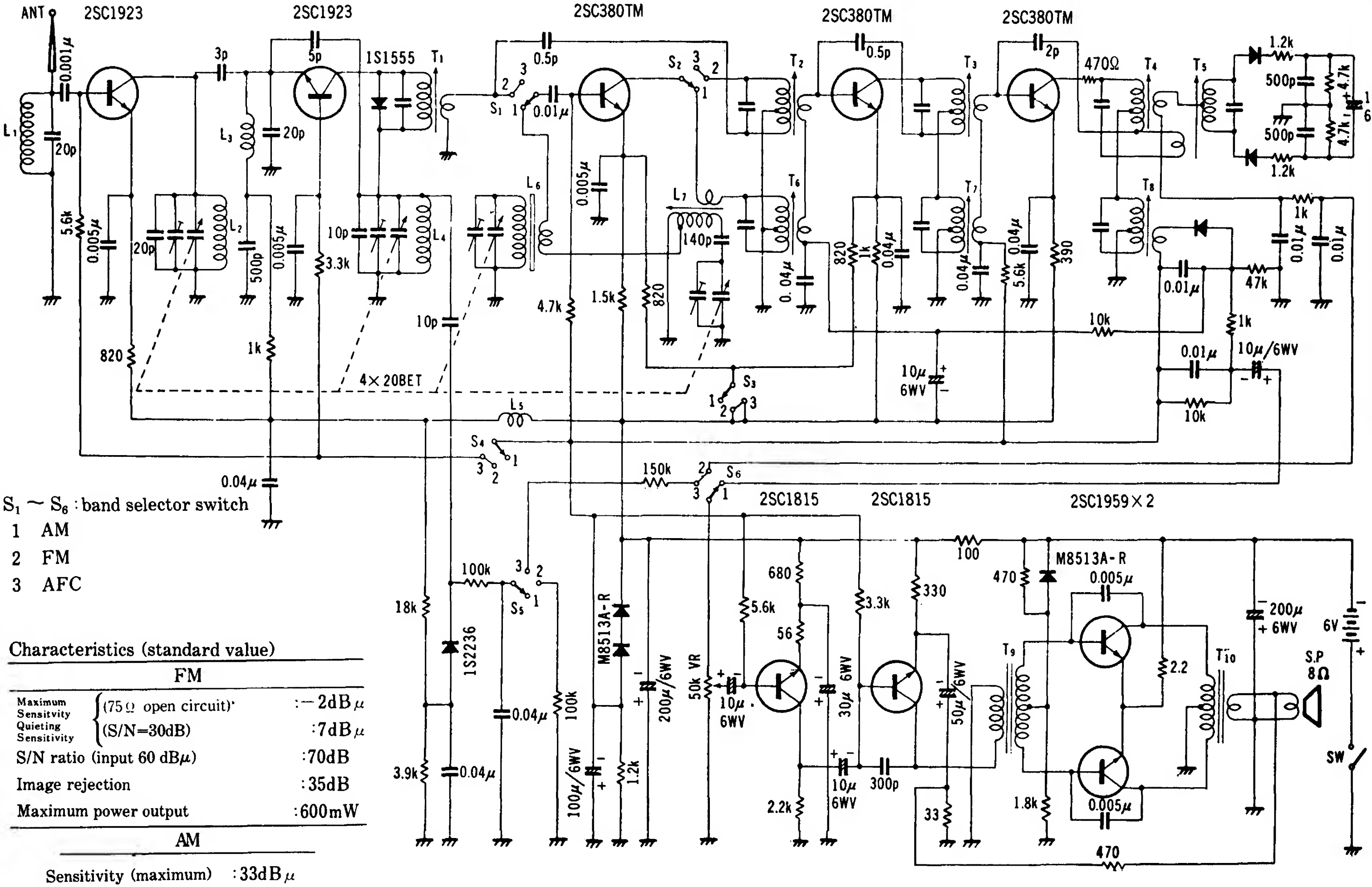
Application of low-saturation voltage transistors

1. Various inductance and lamp drives 1251
2. Wiper control 1251
3. Flasher 1251
4. Ignitor 1251
    (1) Battery drive 1251
    (2) Magnet drive 1251
5. Electronic fuel injection control 1251

GaAs Hall sensor

1. Example circuit using GaAs Hall sensor (Hall motor) 1252

1. 9-transistor FM/AM radio circuit



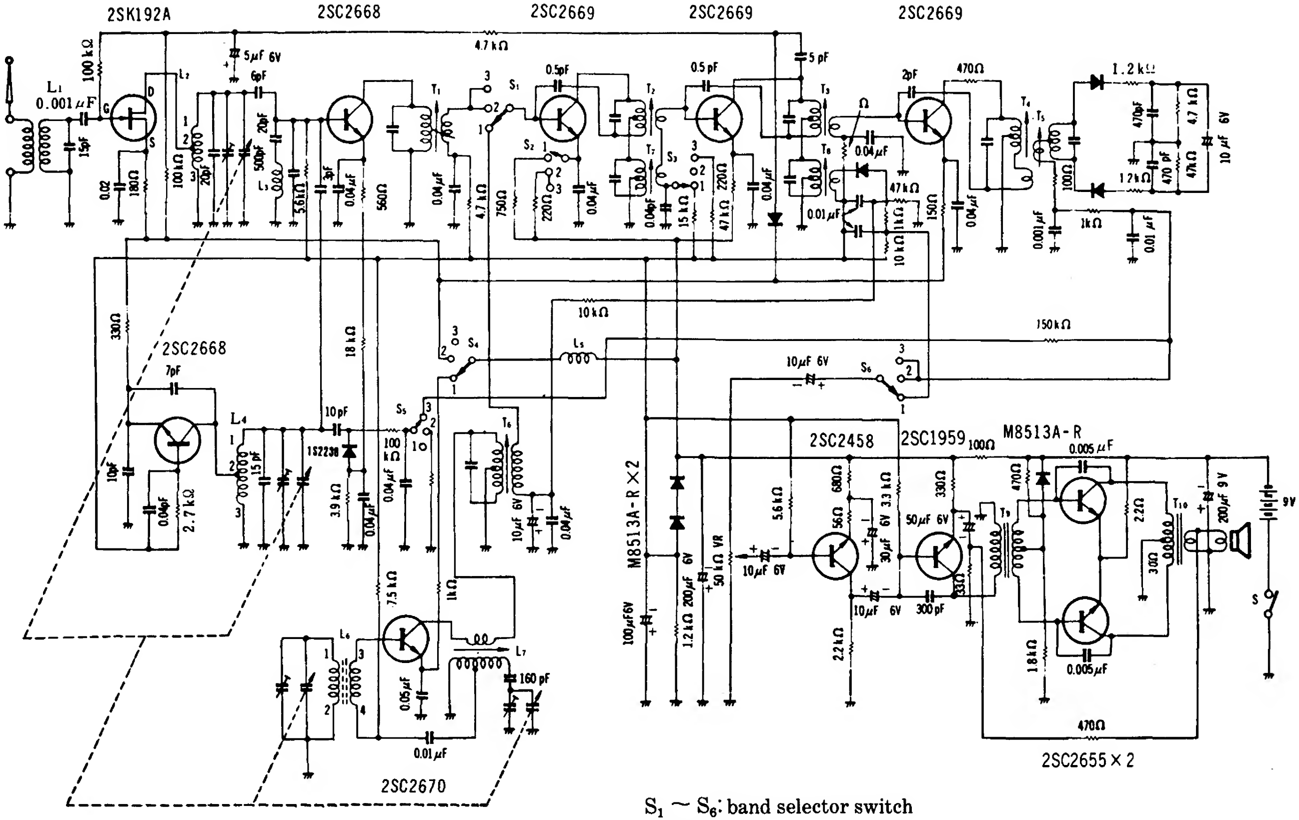
S₁ ~ S₆ : band selector switch
1 AM
2 FM
3 AFC

Units for passive elements are R(Ω), C(F) and L (H) unless otherwise specified.

Characteristics (standard value)

FM		
Maximum Sensitvity	(75Ω open circuit)'	:−2dBμ
Quieting Sensitivity	(S/N=30dB)	:7dBμ
S/N ratio (input 60 dBμ)		:70dB
Image rejection		:35dB
Maximum power output		:600mW
AM		
Sensitivity (maximum)		:33dBμ
S/N ratio (input 60 dBμ)		:35dB
Selectivity (±10kHz)		:24dB
Maximum power output		:600mW

2. 10-transistor FM/AM radio circuit

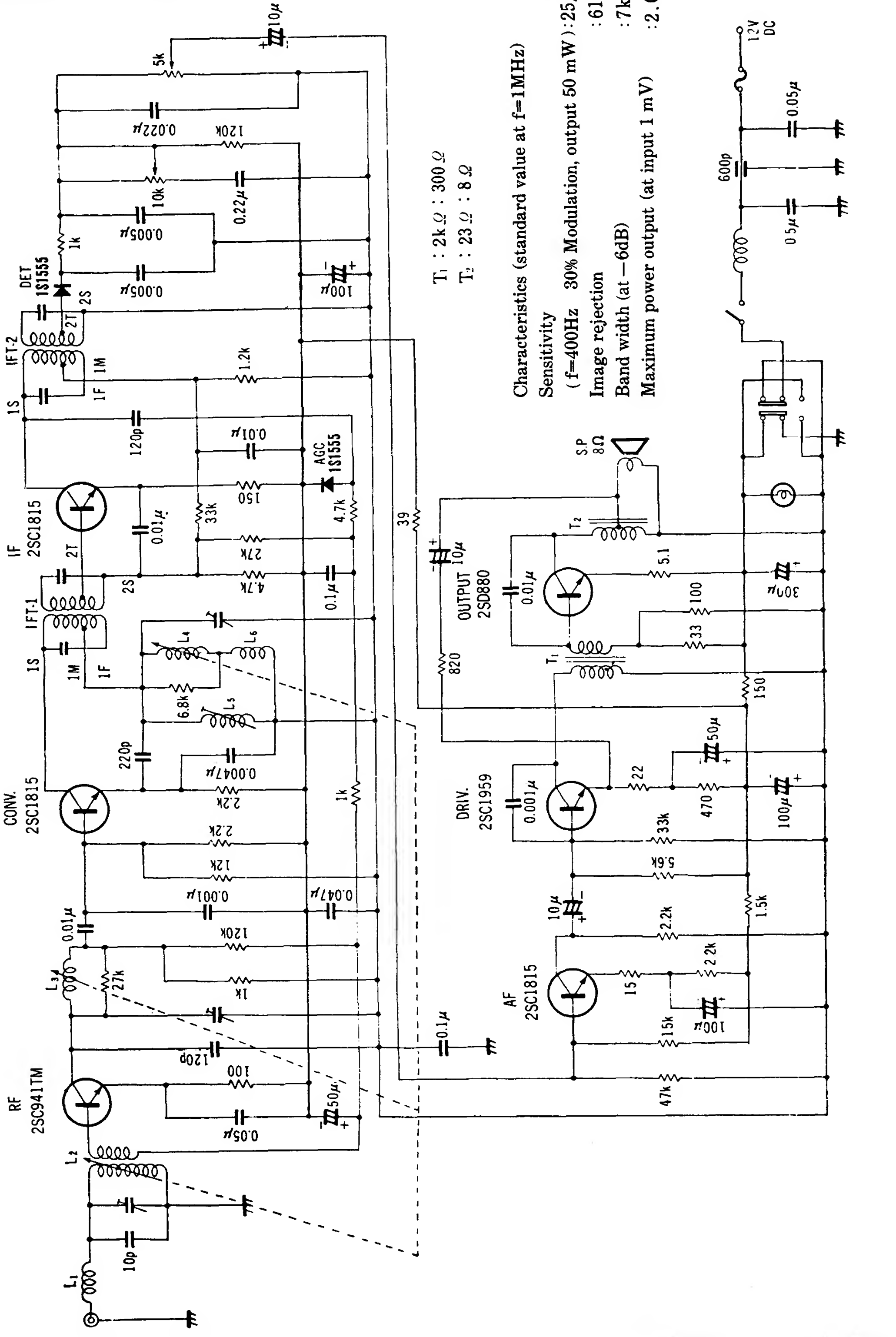


S₁ ~ S₆: band selector switch

1. AM
2. FM
3. AFC

Characteristics (standard value)	FM	AM
Maximum sensitivity (S/N=30dB)	− 2dBμ	35dBμ/m
Maximum sensitivity (75Ω open circuit)	7dBμ	
Quieting sensitivity	66dB	33dB
S/N ratio (input 60 dBμ)	50dB	
Image rejection		
Maximum power output	2500mW	2500mW
Selectivity (±10kHz)		25dB

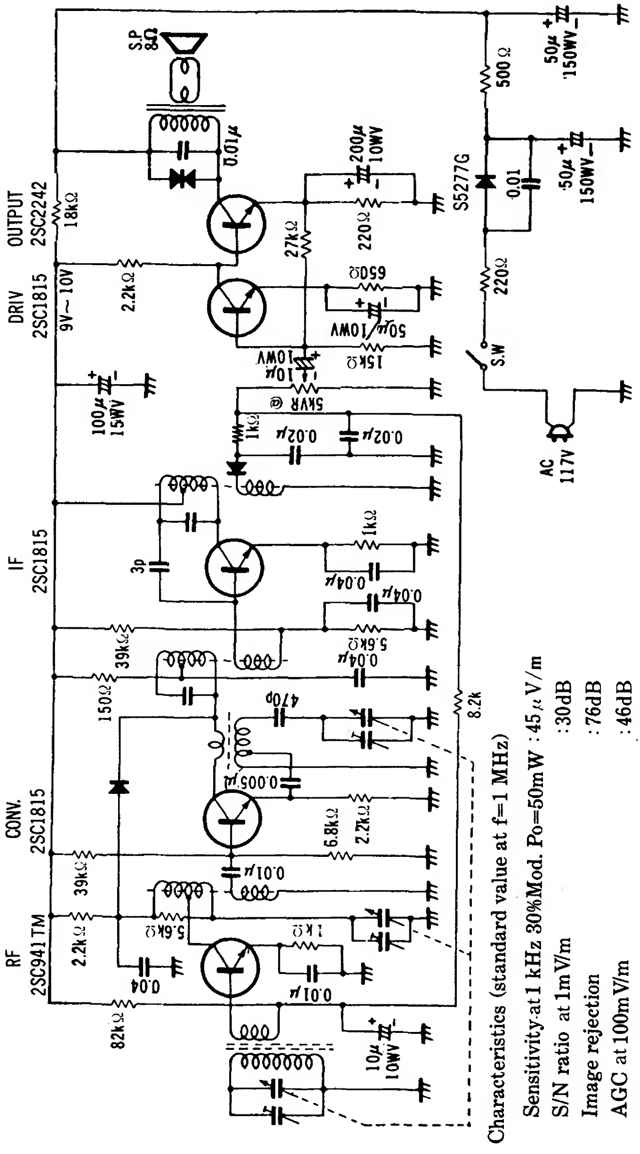
3. 6-transistor car radio circuit



T1 : 2kΩ : 300Ω
T2 : 23Ω : 8Ω

Characteristics (standard value at f=1MHz)
Sensitivity
(f=400Hz 30% Modulation, output 50 mW) : 25μV
Image rejection : 61dB
Band width (at −6dB) : 7kHz
Maximum power output (at input 1 mV) : 2.0W

4. 5-transistor line operate radio circuit

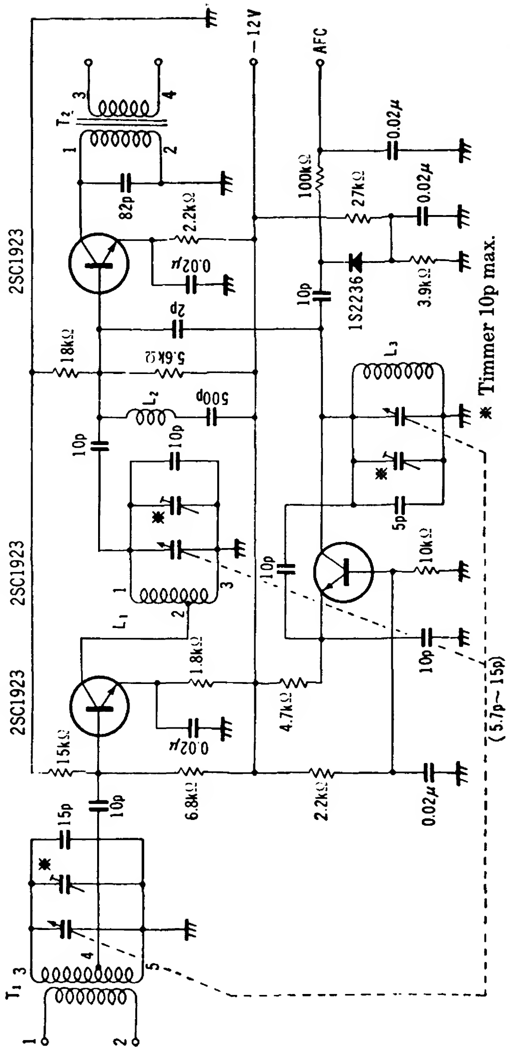


Characteristics (standard value at f=1 MHz)

Sensitivity at 1 kHz 30%Mod. Po=50mW : 45μV/m
S/N ratio at 1mV/m : 30dB
Image rejection : 76dB
AGC at 100mV/m : 46dB
Band width at −6dB : 6kHz
Maximum power output at 5mV/m : 2.0W

FM stereo unit

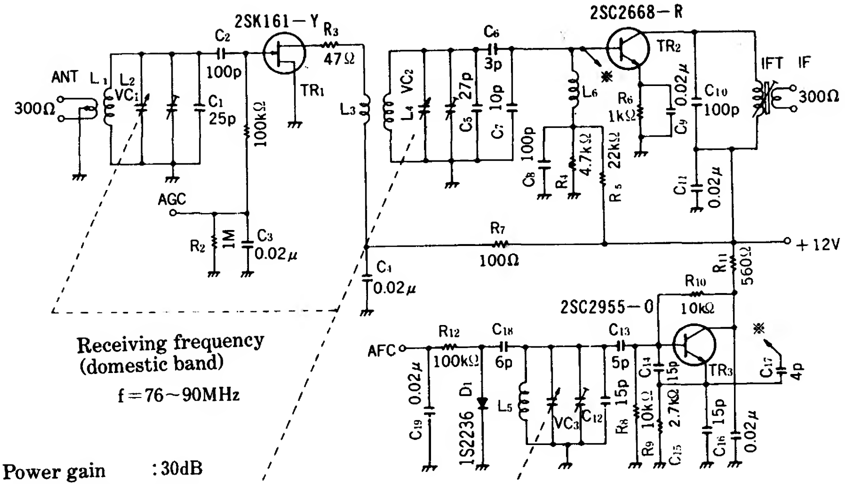
1. FM tuner circuit (1)



Characteristics (standard value)

Receiving frequency	: 88~108MHz
Input impedance	: 75Ω
Power gain	: 32dB
Image rejection	: 50dB
Oscillation voltage	: 190mV
Oscillator dropout voltage	: 3.2V

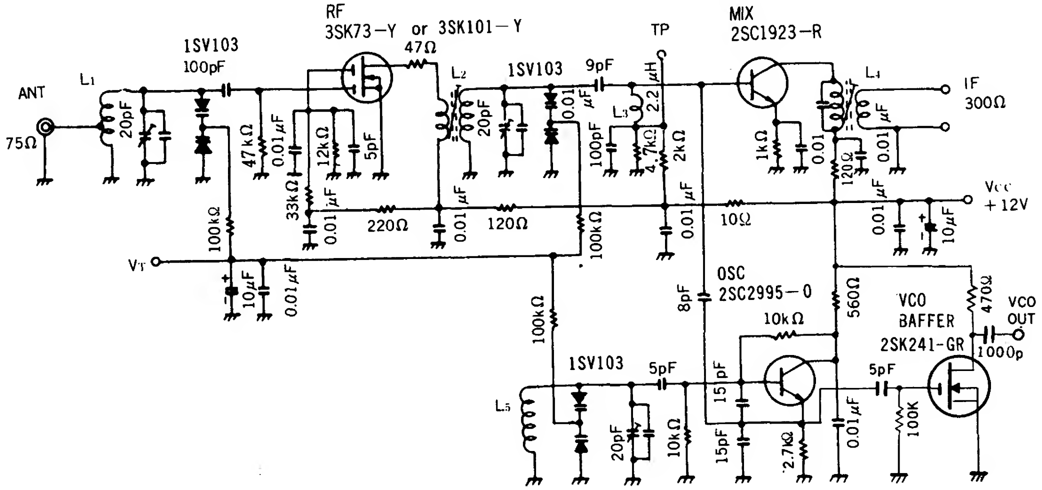
2. FM tuner circuit (2)



Receiving frequency
(domestic band)
f=76~90MHz

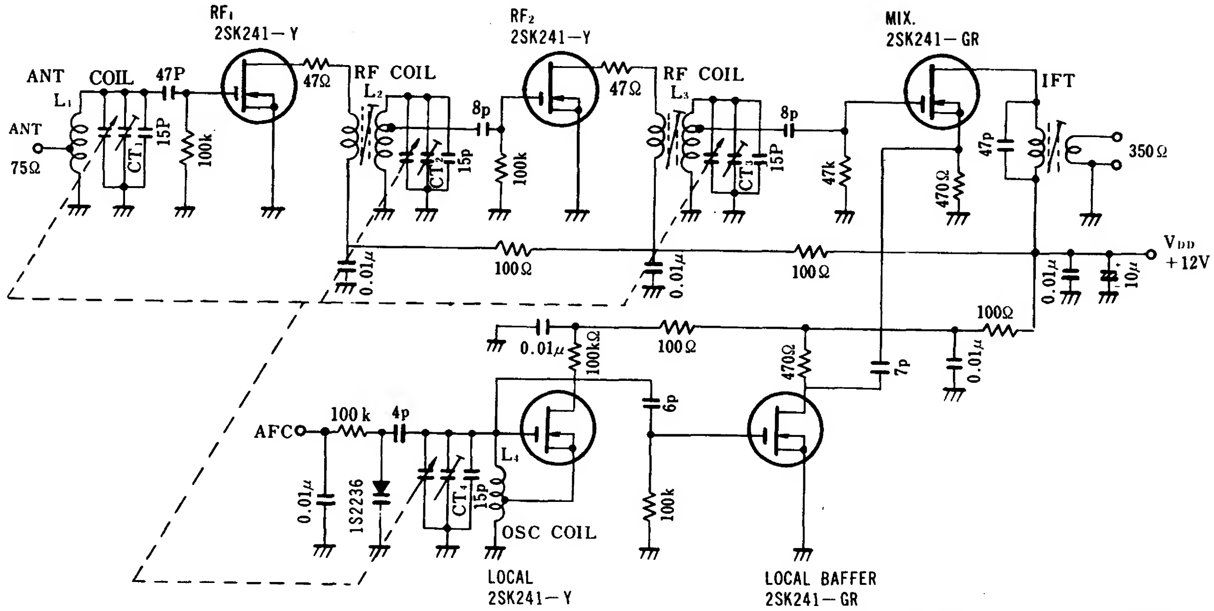
Power gain :30dB
Image rejection :68dB
S/N ratio :77dB

3. FM electronic tuner Circuit



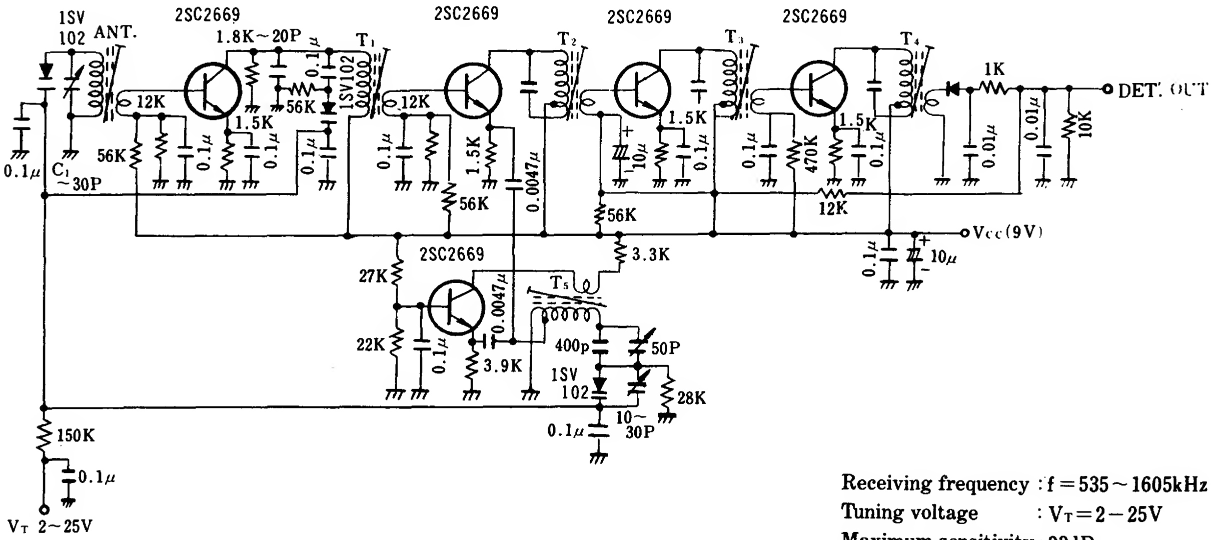
Receiving frequency : f=76~90MHz
Tuning voltage : VT=3~25V
Power gain : 32dB
Image rejection : 62dB
S/N ratio : 74dB

4. Hi-Fi FM tuner Circuit



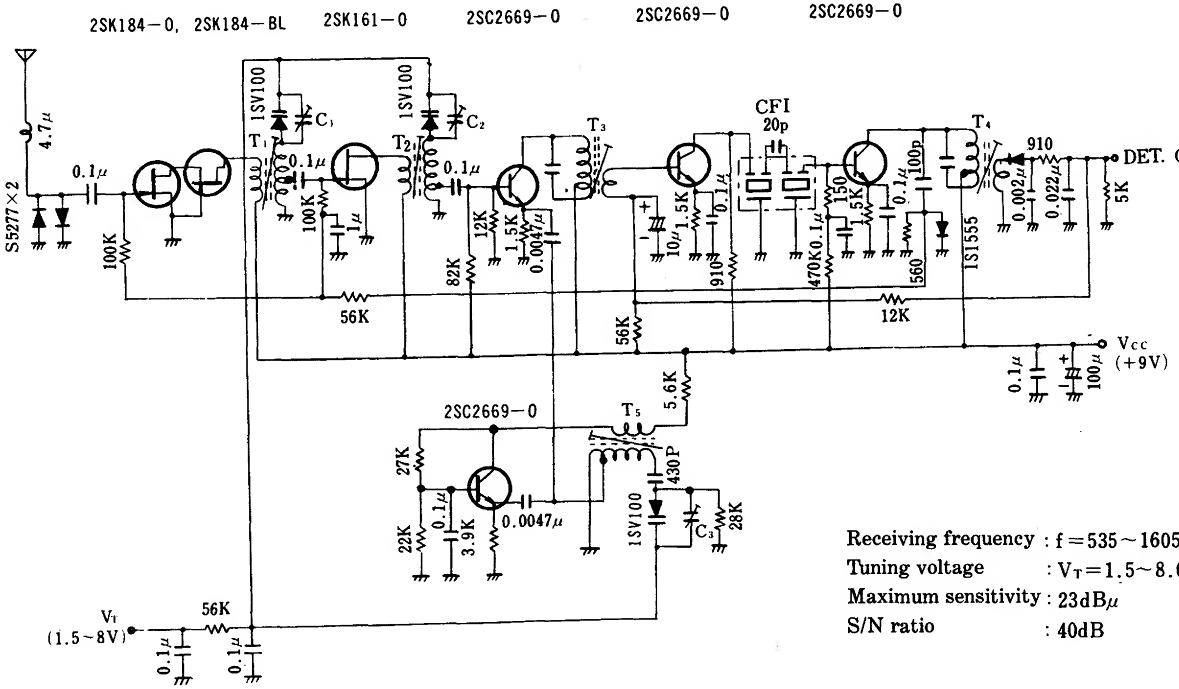
Receiving frequency : f＝76～90MHz
Power gain : 33dB
Image rejection : 85dB
S/N ratio : 80dB

5. Electronic tuning AM tuner Circuit (for Hi-Fi)



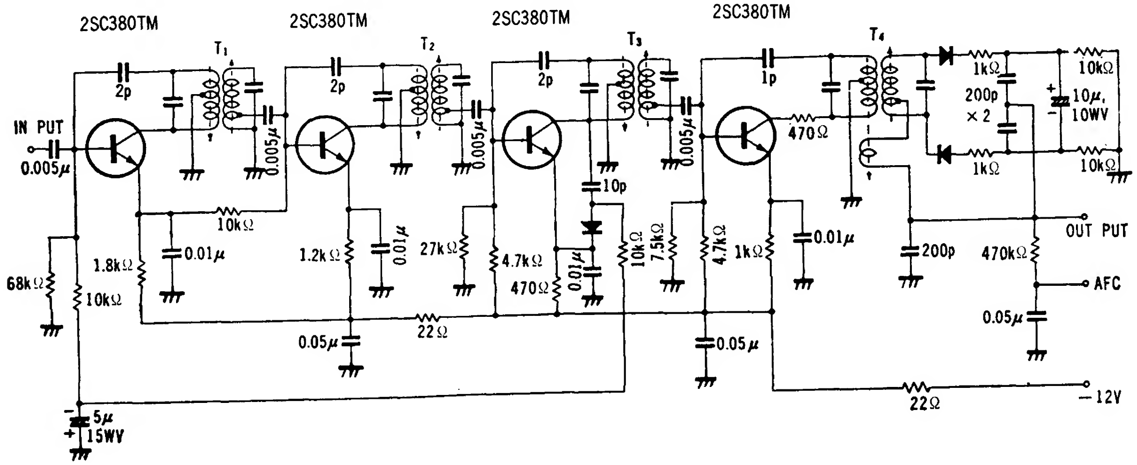
Receiving frequency : f＝535～1605kHz
Tuning voltage : VT＝2－25V
Maximum sensitivity : 33dBμ
S/N ratio : 48dB

6. Electronic tuning AM tuner Circuit (for automotive use)

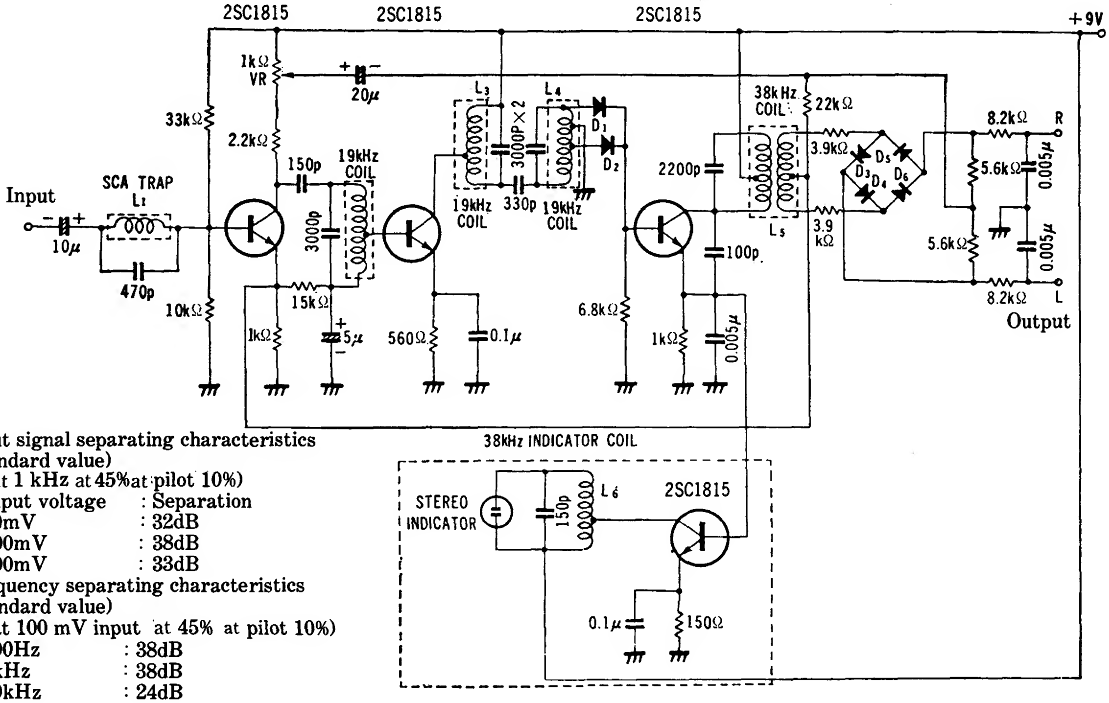


Receiving frequency	: f = 535 ~ 1605kHz
Tuning voltage	: V_T = 1.5 ~ 8.0V
Maximum sensitivity	: 23dBμ
S/N ratio	: 40dB

7. FM IF amplifier circuit



8. FM multiplex circuit



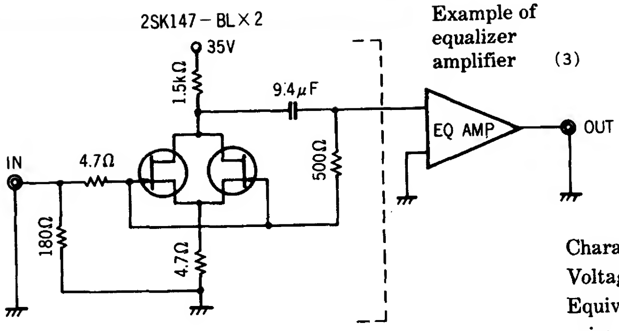
Input signal separating characteristics
(standard value)
(at 1 kHz at 45% at pilot 10%)
Input voltage : Separation
30mV : 32dB
100mV : 38dB
200mV : 33dB

Frequency separating characteristics
(standard value)
(at 100 mV input at 45% at pilot 10%)
100Hz : 38dB
1kHz : 38dB
10kHz : 24dB

Audio amplifier circuits

1. Preamplifier circuit

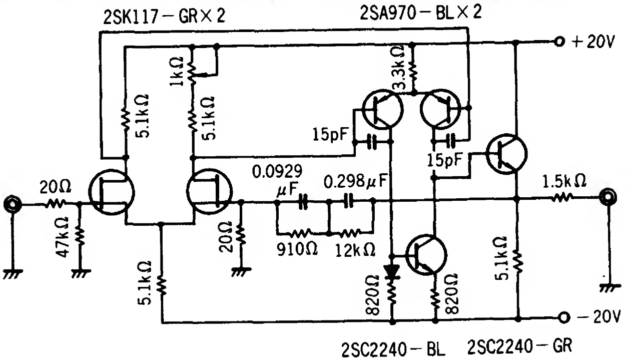
(1) MC head amplifier using 2SK147



Characteristics		
Voltage gain	: f=1kHz (head)	27dB
Equivalent input noise voltage	: Input open	−158.5dBV
S/N	: Vi=0.2mV	84.5dB

2. Preamplifier circuit

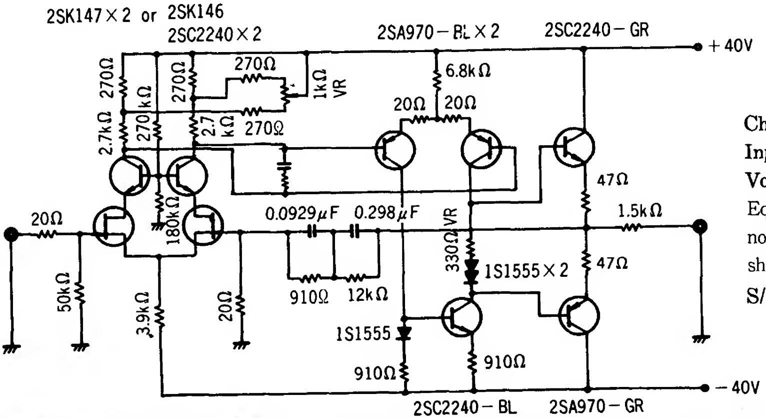
(2) First-stage equalizer amplifier using 2SK117



Characteristics		
Input impedance	: f=1kHz	47kΩ
Voltage gain	: f=1kHz	35.0dB
Equivalent input noise voltage	: Input short-circuited, IHF A curve	−140.2dBV
S/N	Vi=2mV	86.2dB

3. Preamplifier circuit

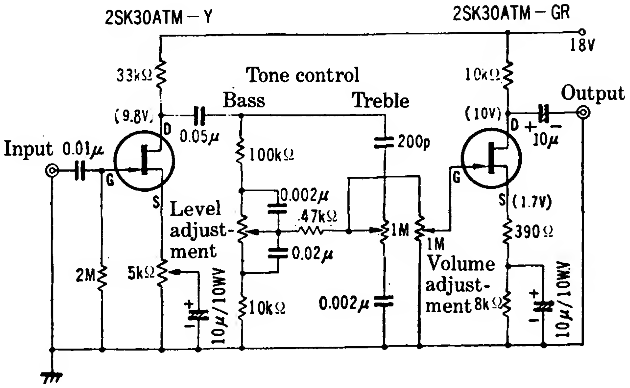
(3) First-stage equalizer amplifier using 2SK147 or 2SK146



Characteristics		
Input impedance	: f=1kHz	50kΩ
Voltage gain	f=1kHz	35dB
Equivalent input noise voltage input short-circuited	IHFA curve IHF A curve curve	−143.8dBV
S/N	: Vi=2mV.	89.9dB

4. Preamplifier circuit

(4) Ceramic crystal cartridge application



Item	Level adjustment		Conditions
	Min.	Max.	
Gain	14dB	28dB	Frequency response: flat, volume max.
S/N	70dB or more	80dB or more	Frequency response: flat, volume max. 1kHz, 100mV, Input opened
TOTAL HARMONIC DISTORTION	0.5% or less	3% or less	1kHz, 1V output, volume medium

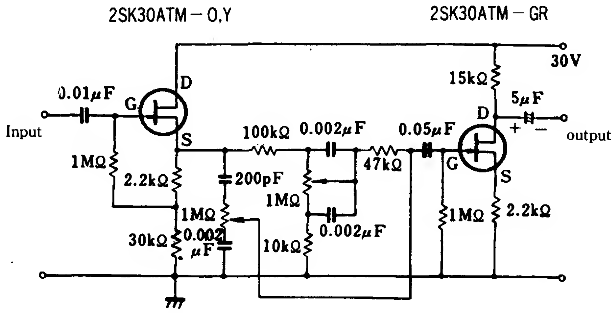
Tone control characteristics

Bass : ±12dB @100Hz

Treble : ±12dB @10kHz

5. Preamplifier circuit

(5) CR-type tone control circuit

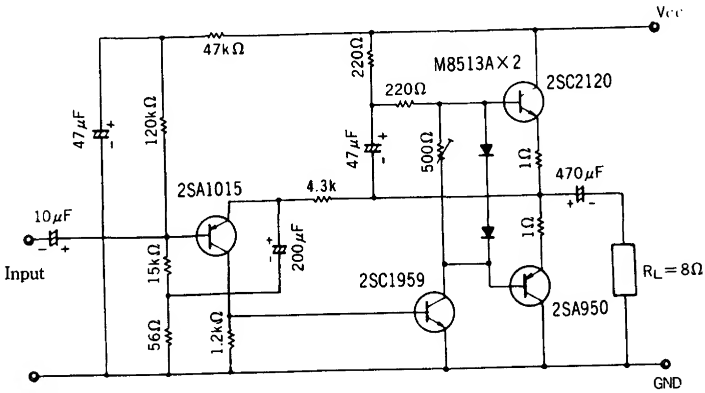


Input impedance : 10kΩ (MIN)

Gain reduction : −8.9dB (f = 1kHz)

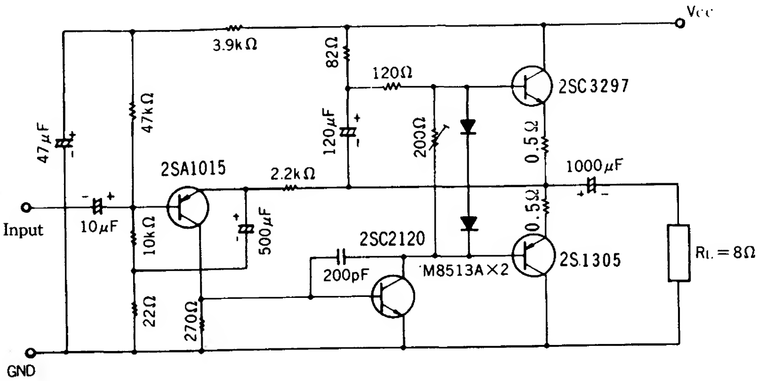
Maximum output voltage : 5V (f = 1kHz)

6. Power amplifier circuit for 1.5W output power



Supply voltage : 13V
Load impedance : 8Ω
Input impedance : 17kΩ
Voltage gain : 38dB
Negative feedback : 28dB
Output power : 1.5W @ KF = 5%, f = 1kHz
Idle current : 10mA
Frequency response : 20Hz ~ 50kHz @ −3dB
T.H.D. : 0.6% @ P_O = 0.1W f = 1kHz
: 1.5% @ P_O = 1W f = 1kHz

7. Power amplifier circuit for 5W output power



Supply voltage : 20V
Load impedance : 8Ω
Input impedance : 15kΩ @ f = 1kHz
Voltage gain : 40dB @ f = 1kHz
Negative feedback : 27.5dB @ f = 1kHz
Output power : 5W @ KF = 5%, f = 1kHz
Idle current : 7mA
Freguency Response : 20Hz ~ 50kHz @ −3dB
T.H.D. : 0.3% @ 0.1W, f = 1kHz
0.2% @ 1W, f = 1kHz
0.5% @ 4W, f = 1kHz

8. Power amplifier circuit for 35～80W output power

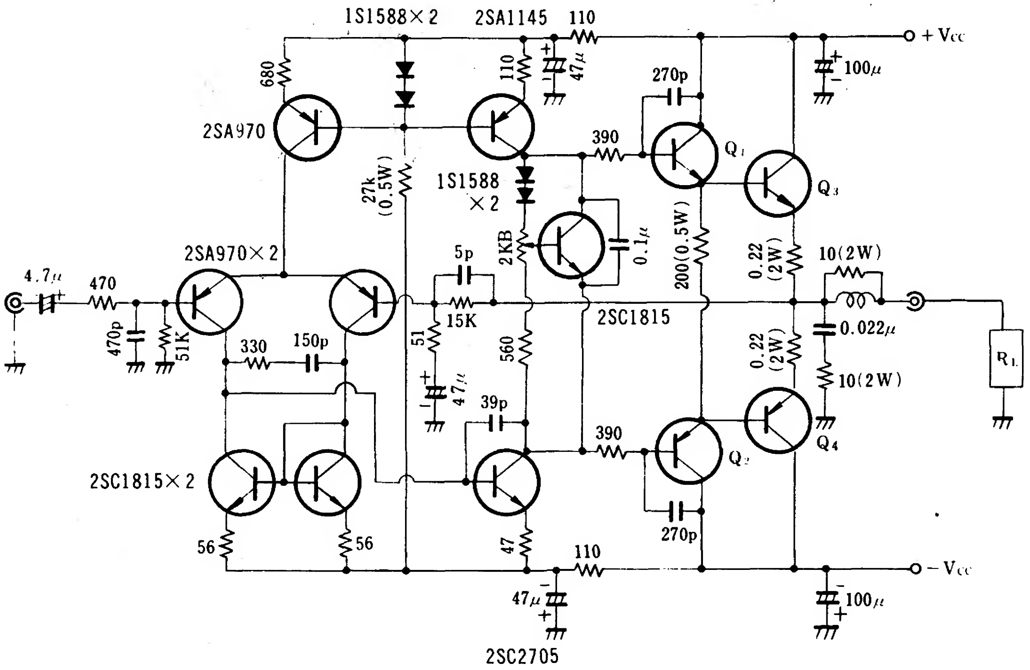


Fig. 1

Output power Po(W)	Supply voltage ±Vcc(V)	Transistors			
		Q1	Q2	Q3	Q4
35	±31	2SC1627A	2SA817	2SC3180	2SA1263
50	±36	2SC2235	2SA965	2SC3181	2SA1264
70	±41	2SC2824	2SA1184	2SC3182	2SA1265
80	±45	2SC3298	2SA1306	2SC3280	2SA1301

Load impedance : 8Ω

Input impedance : 51kΩ @f = 1kHz

Voltage gain : 29.7dB @f = 1kHz

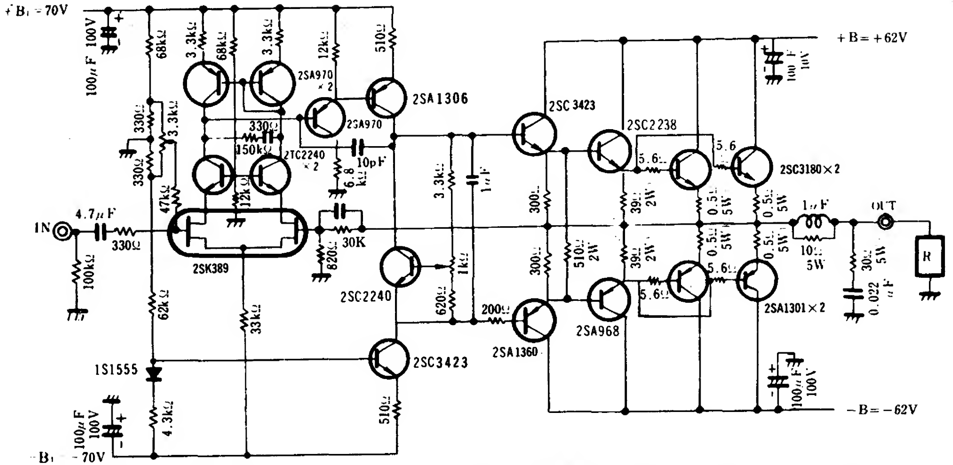
Output power : Po (See Fig. 1) @f = 20～20kHz THD = 0.02%

Idle current : 30mA

Frequency response : 20～100kHz @ −1dB

T. H. D. : 0.002% @ Po = 30W f = 1kHz

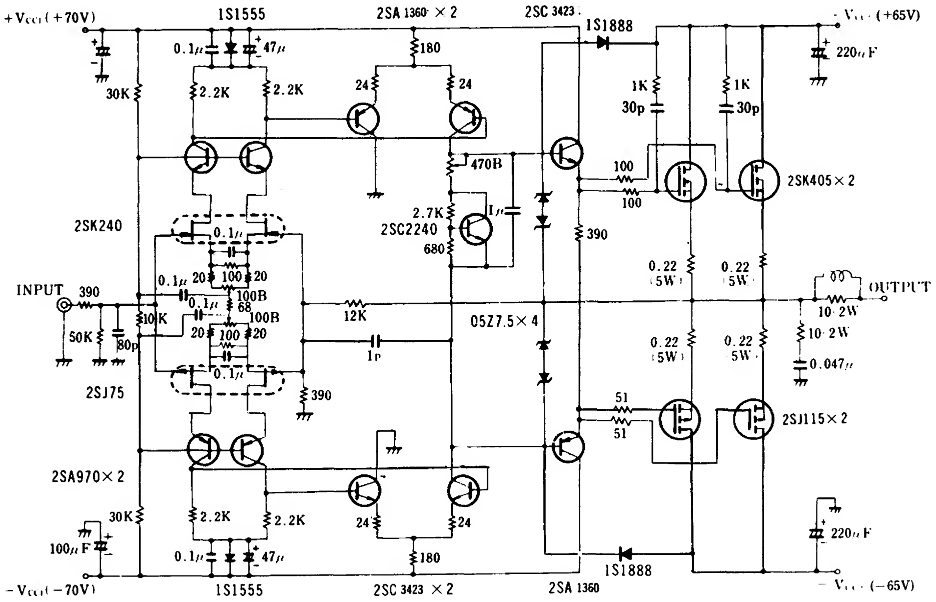
9. Power amplifier circuit for 120W output power



Supply voltage : $\pm B_1 = \pm 70V$, $\pm B_2 = \pm 62V$ (No Signal)
Load impedance : 8Ω
Input impedance : 32kΩ @ f = 1kHz
Voltage gain : 31dB @ f = 1kHz
Output power : 120W @ f = 20 ~ 20kHz THD = 0.01%
Idle current : 50mA

Frequency Response : 20 ~ 100kHz @ −1dB
T. H. D. : 0.0054% @ P_0 = 1W f = 1kHz
0.0022% @ P_0 = 10W f = 1kHz
0.0016% @ P_0 = 30W f = 1kHz
0.0015% @ P_0 = 60W f = 1kHz
0.0015% @ P_0 = 120W f = 1kHz

10. Power amplifier circuit for 120W output power (using POWER MOS FET)

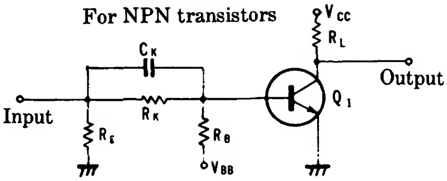


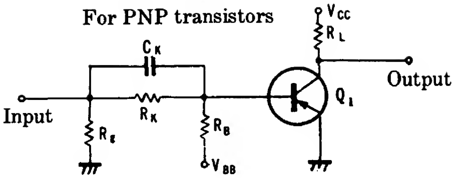
Supply voltage : $\pm V_{cc1} = \pm 70V$, $\pm V_{cc2} = \pm 65V$ (No Signal)
Load impedance : 8Ω
Input impedance : 56kΩ @ f = 1kHz
Voltage gain : 30dB @ f = 1kHz
Output power : 120W @ 20 ~ 100kHz THD = 0.01%
Idle current : 500mA

Frequency response : 20 ~ 100kHz @ −1dB
T. H. D. : 0.0015 @ P_0 = 120W f = 1kHz
0.0025 @ P_0 = 120W f = 20kHz
0.007 @ P_0 = 120W f = 100kHz

Switching circuits

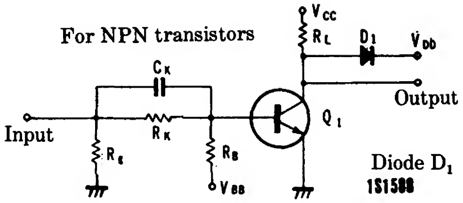
1. Inverter circuit (1)

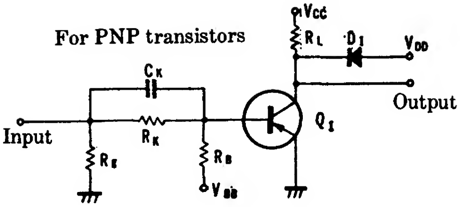

For NPN transistors


For PNP transistors

Transistor Q_1	Circuit constant								Switching time (standard value)			
	V_{CC} (V)	V_{BB} (V)	V_I (V)	R_L (Ω)	R_B (kΩ)	R_K (kΩ)	R_E (Ω)	C_K (pF)	t_d (ns)	t_r (ns)	t_{stg} (ns)	t_f (ns)
2SA495 G TM – O – Y	– 12 〃	3	– 6	1 k 〃	8.2 15	5.6 10	50 〃	100 〃	4 〃	4 〃	20 〃	35 〃
2SA499 – R 2SA500 – O – Y	– 12 〃 〃	3 〃 〃	– 6 〃 〃	1 k 〃 〃	3.9 6.8 12	2.7 5.1 8.2	50 〃 〃	100 〃 〃	4 〃 〃	4 〃 〃	20 〃 〃	35 〃 〃
2SC395A – O – Y	12 〃	– 3	6 〃	390 〃	2.2 3.9	1.5 2.7	50 〃	30 〃	3 〃	3 〃	4 〃	10 〃
2SC400 – O – Y – GR	12 〃	– 3 〃	6 〃 〃	1 k 〃 〃	6.8 12 18	5.1 8.2 12	50 〃 〃	100 〃 〃	4 〃 〃	4 〃 〃	20 〃 〃	35 〃 〃
2SC752 G TM – R – O – Y	12 〃 〃	– 3 〃 〃	6 〃 〃	1 k 〃 〃	3.9 6.8 12	2.7 5.1 8.2	50 〃 〃	15 〃 〃	3 〃 〃	3 〃 〃	4 〃 〃	30 〃 〃
2SC752 G TM R O Y	12 〃 〃	3 〃 〃	6 〃 〃	390 〃 〃	1.5 2.7 4.7	1.0 1.8 3.3	50 〃 〃	20 〃 〃	3 〃 〃	3 〃 〃	3 〃 〃	10 〃 〃
2SC503 O 2SC504 Y GR	15 〃 〃	3 〃 〃	6 〃 〃	100 〃 〃	2.2 3.9 7.5	0.39 0.68 1.5	50 〃 〃	470 560 680	20 〃 〃	10 〃 〃	25 〃 〃	30 〃 〃
2SC372 G TM O 2SC372 G TM – Y 2SC373 G TM	12 〃 〃	3 〃 〃	6 〃 〃	1k 〃 〃	8.2 15 22	5.6 10 15	50 〃 〃	100 〃 〃	4 〃 〃	4 〃 〃	20 〃 〃	35 〃 〃
2SC980 G TM, A G TM – O 2SC980 G TM Y	24 〃 〃	3 〃 〃	6 〃 〃	2.2k 〃 〃	6.8 12 22	3.9 6.8 12	50 〃 〃	100 〃 〃	5 〃 〃	10 〃 〃	40 〃 〃	70 〃 〃

2. Inverter circuit (2)

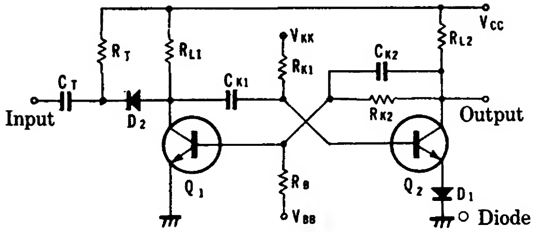




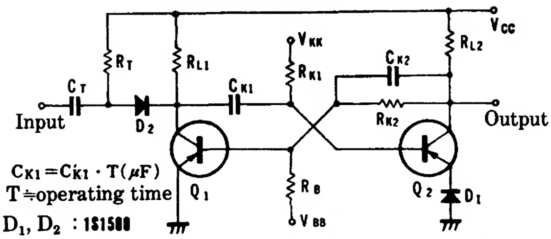
Transistor Q_1	Circuit constant									Switching time			
	V_{CC} (V)	V_{BB} (V)	V_{DD} (V)	R_L (Ω)	R_B (kΩ)	R_K (kΩ)	R_E (Ω)	C_K (pF)	V_1 (V)	t_d (ns)	t_r (ns)	t_{stg} (ns)	t_f (ns)
2SA495ⒼTM −O −Y	−12 〃	3 〃	−6 〃	1 k 〃	8.2 15	5.6 10	50 〃	100 〃	−6 〃	4 〃	4 〃	15 〃	10 〃
2SA499 2SA500 −R −O −Y	−12 〃 〃	3 〃 〃	−6 〃 〃	1 k 〃 〃	3.9 6.8 12	2.7 5.1 8.2	50 〃 〃	100 〃 〃	−6 〃 〃	4 〃 〃	4 〃 〃	15 〃 〃	10 〃 〃
2SC395A −O −Y	12 〃	−3 〃	6 〃	390 〃	2.2 3.9	1.5 2.7	50 〃	30 〃	6 〃	3 〃	3 〃	4 〃	4 〃
2SC752ⒼTM −R −O −Y	12 〃 〃	−3 〃 〃	6 〃 〃	390 〃 〃	1.5 2.7 4.7	1.0 1.8 3.3	50 〃 〃	20 〃 〃	6 〃 〃	3 〃 〃	4 〃 〃	3 〃 〃	4 〃 〃
2SC372ⒼTM −O 2SC372ⒼTM −Y 2SC373ⒼTM	12 〃 〃	−3 〃 〃	6 〃 〃	1 k 〃 〃	8.2 15 22	5.6 10 15	50 〃 〃	100 〃 〃	6 〃 〃	4 〃 〃	4 〃 〃	15 〃 〃	10 〃 〃
2SC400 −O −Y −GR	12 〃 〃	−3 〃 〃	6 〃 〃	1 k 〃 〃	6.8 12 18	5.1 8.2 12	50 〃 〃	100 〃 〃	6 〃 〃	4 〃 〃	4 〃 〃	15 〃 〃	10 〃 〃

3. Monostable multivibrator circuit

For NPN transistors



For PNP transistors



$C_{K1} = C'_{K1} \cdot T (\mu F)$

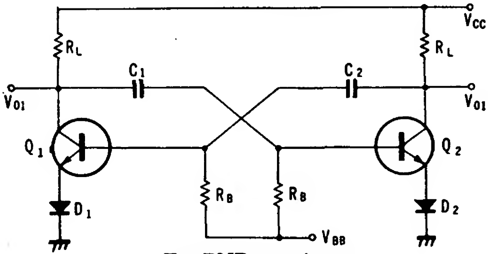
T≒operating time

○ Diode D_1, D_2 : 1S1588

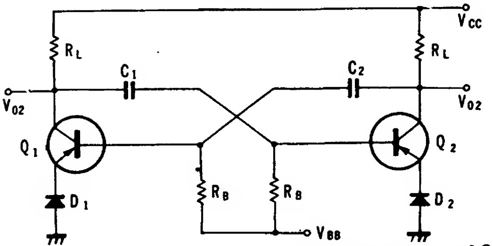
Transistor Q_1, Q_2	Circuit constant												
	V_{CC} (V)	V_{KK} (V)	V_{BB} (V)	V_1 (V)	R_{L1} (Ω)	R_{L2} (Ω)	R_{K1} (Ω)	R_{K2} (kΩ)	R_B (kΩ)	R_T (kΩ)	C'_{K1}	C_{K2} (pF)	C_T (pF)
2SA495Ⓖ TM −O −Y	−12 〃	−12 〃	12 〃	6 〃	1 k 〃	1 k 〃	22 33	22 33	68 120	10 〃	66 44	50 〃	200 〃
2SA499 −R 2SA500 −O −Y	−12 〃 〃	−12 〃 〃	12 〃 〃	6 〃 〃	1 k 〃 〃	1 k 〃 〃	8.2 15 27	8.2 15 27	27 56 100	10 〃 〃	177 97 54	50 〃 〃	200 〃 〃
2SC372Ⓖ TM −O 2SC372Ⓖ TM −Y 2SC373Ⓖ TM	12 〃 〃	12 〃 〃	−12 〃 〃	−6 〃 〃	1 k 〃 〃	1 k 〃 〃	22 33 56	22 33 56	68 120 180	10 〃 〃	66 44 26	50 〃 〃	200 〃 〃
2SC395A −O −Y	12 〃	12 〃	−12 〃	−6 〃	390 〃	390 〃	6.8 12	6.8 12	68 120	3.9 〃	214 121	20 〃	50 〃
2SC400 −R −O −Y −GR	12 〃 〃 〃	12 〃 〃 〃	−12 〃 〃 〃	−6 〃 〃 〃	1 k 〃 〃 〃	1 k 〃 〃 〃	8.2 15 27 42	8.2 15 27 42	27 56 100 156	10 〃 〃 〃	177 97 54 35	50 〃 〃 〃	200 〃 〃 〃
2SC752Ⓖ TM −R −O −Y	12 〃 〃	12 〃 〃	−12 〃 〃	−6 〃 〃	390 〃 〃	390 〃 〃	5.1 8.2 15	5.1 8.2 15	51 82 150	3.9 〃 〃	284 179 97	20 〃 〃	50 〃 〃
2SC980Ⓖ TM, AⒼ TM−O 2SC980Ⓖ TM−Y	24 〃 〃	24 〃 〃	−12 〃 〃	−6 〃 〃	2.2k 〃 〃	2.2k 〃 〃	33 56 100	27 39 75	68 100 180	22 〃 〃	43 26 15	30 〃 〃	300 〃 〃

4. Astable multivibrator circuit

For NPN transistors



For PNP transistors



$C_1 = C'_1 \cdot T_1 \times 10^{-6}$ (F) T_1≒operating time of Q_1

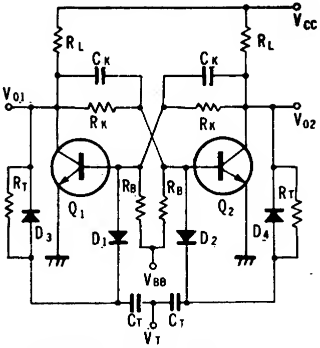
$C_2 = C'_2 \cdot T_2 \times 10^{-6}$ (F) T_2≒Operating time of Q_2

○ Diodes D_1, D_2 : 1S1588

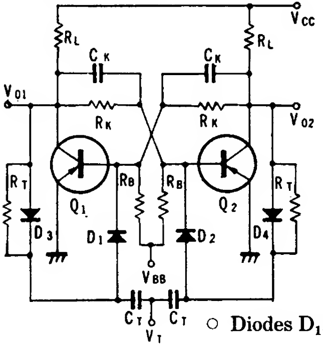
Transistors Q_1, Q_2	Circuit constant					
	V_{CC} (V)	V_{BB} (V)	R_L Ω	R_B kΩ	C'_1	C'_2
2SA495Ⓖ TM −O −Y	−12 〃	−12 〃	1 k 〃	27 47	54 31	54 31
2SA499 −R 2SA500 −O −Y	−12 〃 〃	−12 〃 〃	1 k 〃 〃	12 22 39	121 66 37	121 66 37
2SC395A −O −Y	12 〃	12 〃	390 〃	6.8 12	214 121	214 121
2SC752Ⓖ TM −R −O −Y	12 〃 〃	12 〃 〃	390 〃 〃	5.1 8.2 15	284 177 97	284 177 97
2SC372Ⓖ TM −O 2SC372Ⓖ TM −Y 2SC373Ⓖ TM	12 〃 〃	12 〃 〃	1 k 〃 〃	27 47 68	54 31 21	54 1 21
2SC400 −O −Y −GR	12 〃 〃	12 〃 〃	1 k 〃 〃	22 39 56	66 37 26	66 37 26
2SC980Ⓖ TM, AⒼ TM−O 2SC980Ⓖ TM−Y	24 〃 〃	24 〃 〃	2.2k 〃 〃	33 56 100	44 26 15	44 26 15

5. Fixed-bias type flip-flop circuit

For NPN transistors



For PNP transistors

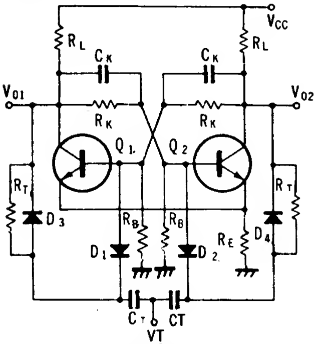


Transistors Q1, Q2		Circuit constant								
		V_{CC} (V)	V_{BB} (V)	V_T (V)	R_L (Ω)	R_K (kΩ)	R_B (kΩ)	R_T kΩ	C_K (pF)	C_T pF
2SA495Ⓖ TM	−O	−12	12	6	1 k	22	100	10	50	200
	−Y	〃	〃	〃	〃	39	180	〃	〃	〃
2SA499	−R	−12	12	6	1 k	8.2	39	10	50	200
2SA500	−O	〃	〃	〃	〃	18	82	〃	〃	〃
	−Y	〃	〃	〃	〃	33	150	〃	〃	〃
2SC395A	−O	12	−12	−6	390	6.8	68	10	15	50
	−Y	〃	〃	〃	〃	12	120	〃	〃	〃
2SC752Ⓖ TM	−R	12	−12	−6	390	5.1	56	10	15	50
	−O	〃	〃	〃	〃	8.2	82	〃	〃	〃
	−Y	〃	〃	〃	〃	15	150	〃	〃	〃
2SC372Ⓖ TM	−O	12	−12	−6	1 k	22	100	10	50	200
2SC372Ⓖ TM	−Y	〃	〃	〃	〃	39	180	〃	〃	〃
2SC373Ⓖ TM		〃	〃	〃	〃	68	270	〃	〃	〃
2SC400	−O	12	−12	−6	1 k	18	82	10	50	200
	−Y	〃	〃	〃	〃	33	150	〃	〃	〃
	−GR	〃	〃	〃	〃	56	220	〃	〃	〃
2SC980Ⓖ TM,		24	−12	−6	2.2k	27	68	22	30	250
AⒼ TM	−O	〃	〃	〃	〃	39	100	〃	〃	〃
2SC980Ⓖ TM	−Y	〃	〃	〃	〃	75	180	〃	〃	〃

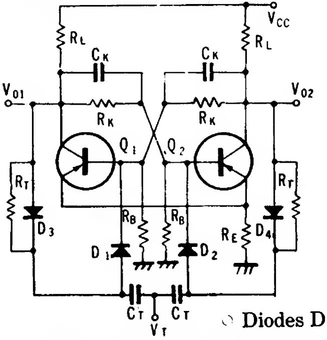
○ Diodes D_1, D_2, D_3, and D_4 : 1S1588

6. Self-bias type flip-flop circuit

For NPN transistors



For PNP transistors

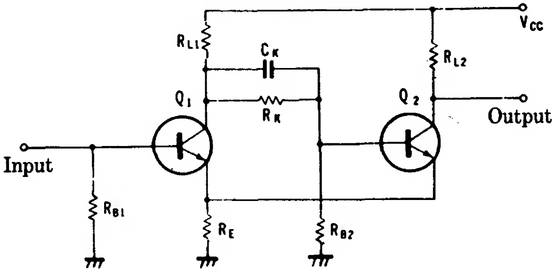


Transistors Q1, Q2		Circuit constant								
		V_{CC} (V)	V_T (V)	R_L (Ω)	R_K kΩ	R_B kΩ	R_E Ω	R_T kΩ	C_K pF	C_T pF
2SA495Ⓖ TM	−O	−12	6	1 k	15	8.2	120	10	50	200
	−Y	〃	〃	〃	27	18	150	〃	〃	〃
2SA499	−R	−12	6	1 k	6.8	2.7	56	10	50	200
2SA500	−O	〃	〃	〃	12	5.6	120	〃	〃	〃
	−Y	〃	〃	〃	18	10	150	〃	〃	〃
2SC395A	−O	12	−6	330	4.7	2.7	47	10	20	50
	−Y	〃	〃	〃	8.2	5.6	56	〃	〃	〃
2SC752Ⓖ TM	−R	12	−6	330	3.3	1.8	33	10	20	50
	−O	〃	〃	〃	6.8	5.6	51	〃	〃	〃
	−Y	〃	〃	〃	10	6.8	56	〃	〃	〃
2SC372Ⓖ TM	−O	12	−6	1 k	15	8.2	120	10	50	200
2SC372Ⓖ TM	−Y	〃	〃	〃	27	18	150	〃	〃	〃
2SC373Ⓖ TM		〃	〃	〃	47	27	180	〃	〃	〃
2SC400	−O	12	−6	1 k	12	5.6	120	10	50	200
	−Y	〃	〃	〃	18	10	150	〃	〃	〃
	−GR	〃	〃	〃	33	18	180	〃	〃	〃
2SC980Ⓖ TM.		24	−6	2.2k	27	18	220	22	30	300
AⒼ TM	−O	〃	〃	〃	39	33	〃	〃	〃	〃
2SC980Ⓖ TM	−Y	〃	〃	〃	68	56	〃	〃	〃	〃

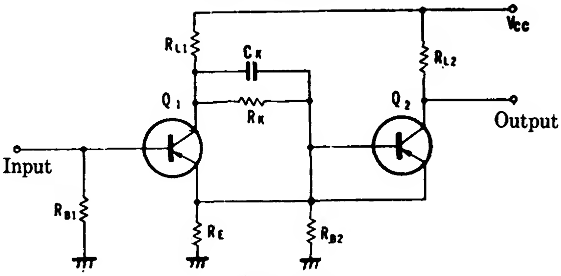
○ Diodes D_1, D_2, D_3, and D_4 : 1S1588

7. Schmidt circuit

For NPN transistors



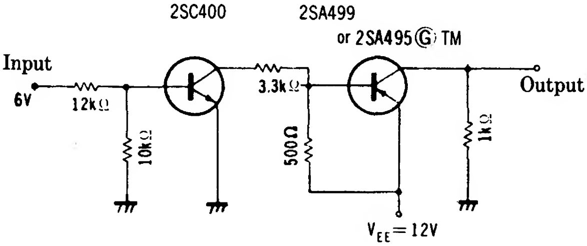
For PNP transistors



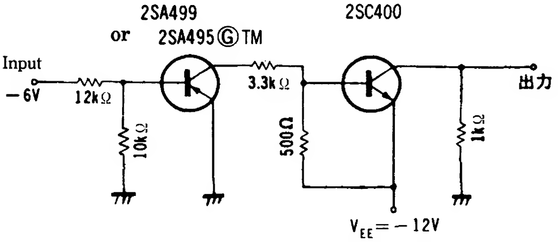
Transistors Q_1, Q_2		Circuit constant									Switching time (standard value)		
		V_{CC} (V)	V_I (V)	R_{L1} (Ω)	R_{L2} (Ω)	R_K (kΩ)	R_E (Ω)	R_{B1} (kΩ)	R_{B2} (kΩ)	C_K (pF)	t_{on} (ns)	t_{off} (ns)	V_H * (V)
2SA495Ⓖ TM	O	12	3	1 k	1 k	15	180	10	10	50	60	120	−1.0
	Y	〃	〃	〃	〃	27	〃	18	18	〃	〃	〃	〃
2SA499 2SA500	R	12	3	1 k	1 k	6.8	180	5.6	5.6	50	60	120	−1.0
	O	〃	〃	〃	〃	15	〃	12	12	〃	〃	〃	〃
	Y	〃	〃	〃	〃	22	〃	15	15	〃	〃	〃	〃
2SC372Ⓖ TM	O	12	3	1 k	1kk	15	180	10	10	50	60	120	1.0
2SC372Ⓖ TM	Y	〃	〃	〃	〃	27	〃	18	18	〃	〃	〃	〃
2SC373Ⓖ TM		〃	〃	〃	〃	47	〃	33	33	〃	〃	〃	〃
2SC395A	O	12	3	330	330	4.7	68	3.9	3.9	20	20	20	−0.5
	Y	〃	〃	〃	〃	6.8	〃	5.6	5.6	〃	〃	〃	〃
2SC400	O	12	3	1k	1 k	15	180	12	12	50	60	120	1.0
	Y	〃	〃	〃	〃	22	〃	15	15	〃	〃	〃	〃
	GR	〃	〃	〃	〃	39	〃	22	22	〃	〃	〃	〃
2SC752Ⓖ TM	R	12	3	330	330	3.3	68	3.3	3.3	20	20	25	−0.5
	O	〃	〃	〃	〃	5.1	〃	3.9	3.9	〃	〃	〃	〃
	Y	〃	〃	〃	〃	8.2	〃	5.6	5.6	〃	〃	〃	〃

* Hysterisis voltage

8. Positive pulse amplifier circuit



9. Negative pulse amplifier circuit

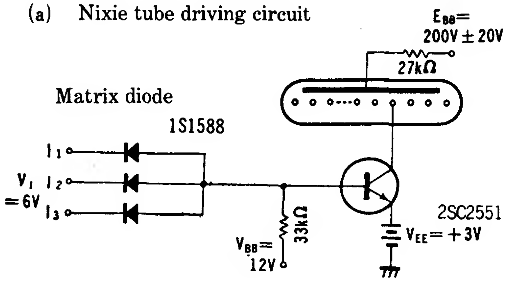


Input/Output switching time. (standard value) unit:ns

	t_d	t_r	t_{stg}	t_f
Positive pulse	110	50	600	45
Negative pulse	125	70	600	45

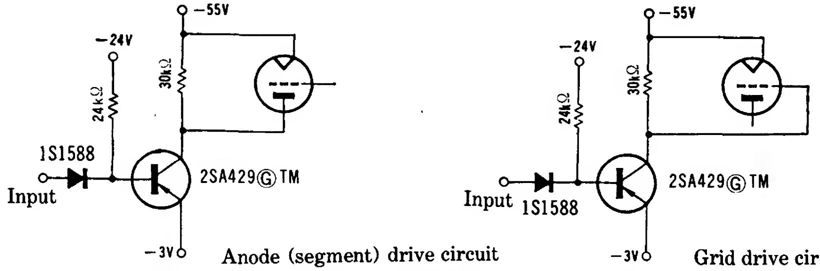
10. Indication tube driving circuit

(a) Nixie tube driving circuit



Operating temperature range			−10℃～+55℃
Minimum input voltage for lighting on			4 V
Maximum input voltage for lighting off			2.5V
Indicator characteristics	Discharge sustaining voltage		～140V
	Allowable average cathode DC current	Figure pole	1.5～3.0mA
		Decimal point pole	0.6～1.5mA

(b) Indication tube driving circuit (Digitron or others)

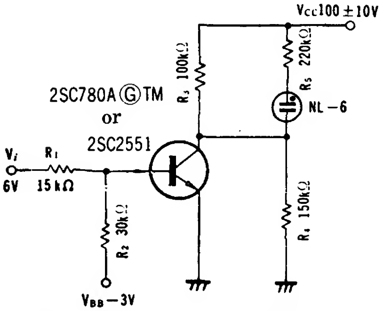


Anode (segment) drive circuit

Grid drive circuit

Operating temperature range			−10℃～60℃
Minimum input voltage for lighting on			−4 V
Maximum input voltage for lighting off			−2.5V
Indicator charac-teristics	Max./min. fluorescent segment voltage		±20～±30 V dc
	Average current for fluorescent. segment	Pole	1～3 mA
		Figure	0.1～0.2mA

(c) Neon tube driving circuit



Transistors used : 2SC780AⒼTM

Supply voltage : $V_{CC}=100\pm10$ V

Input drive voltage : $V_i = 6$ V

Base bias current : $V_{BB}=-3$ V

Neon lamp lighting characteristics

Rated voltage : $V_P=100$ V

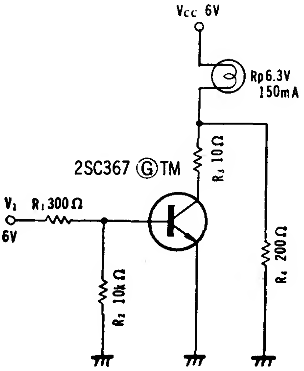
Rated current : $I_P=0.3$ A

Discharge starting voltage : $V_N=85$ V

Discharge stopping voltage : $V_F=55$ V

External series resistance : $R_5=220$ kΩ

(d) Pilot lamp driving circuit



Transistors used : 2SC367ⒼTM

Supply voltage : $V_{CC}=6$ V

Input drive voltage : $V_i=6$ V

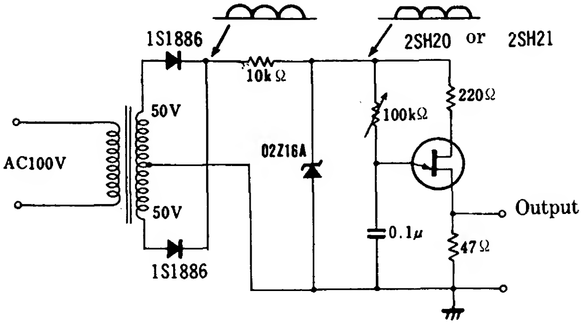
Lamp characteristics

Rated voltage : $V_P=6.3$ V

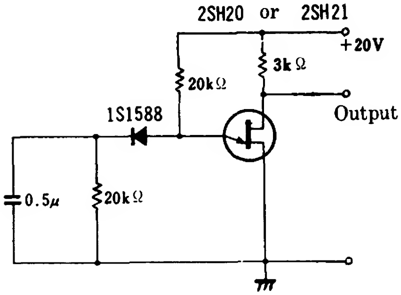
Rated current : $I_P=150$ mA

11. UJT application circuits

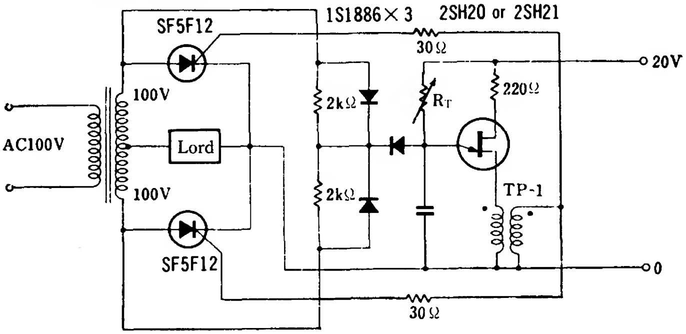
(1) Synchronous circuit with AC power source



(2) Square-wave oscillating circuit

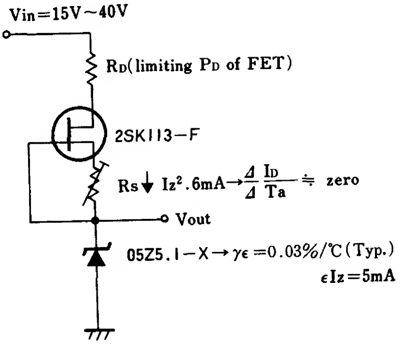


(3) SCR igniting phase controlling circuit

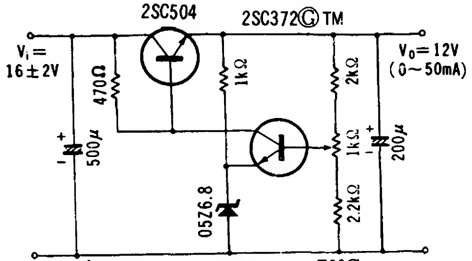


Dropper Regulator Circuit

1. High-stability reference regulator circuit

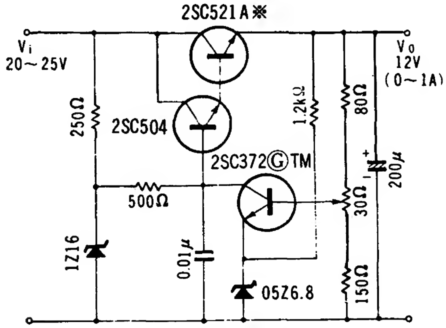


2. Constant-voltage regulator circuit (1) 12V, 50 mA



Ambient temperature~70°C

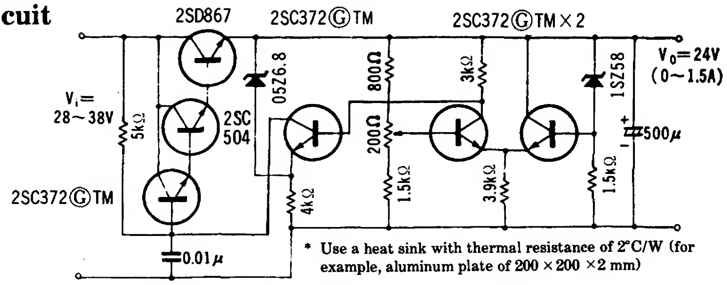
3. Constant-voltage regulator circuit (2) 12V, 1A



Ambient temperatureTa=−20~70°C

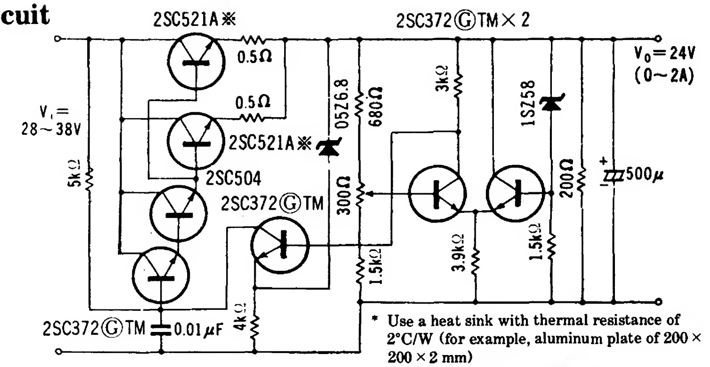
* Use a heat sink with thermal resistance of 2°C/W (for example, aluminum plate of 200 ×200 ×2 mm)

4. Constant-voltage regulator circuit (3) 24V, 1.5A



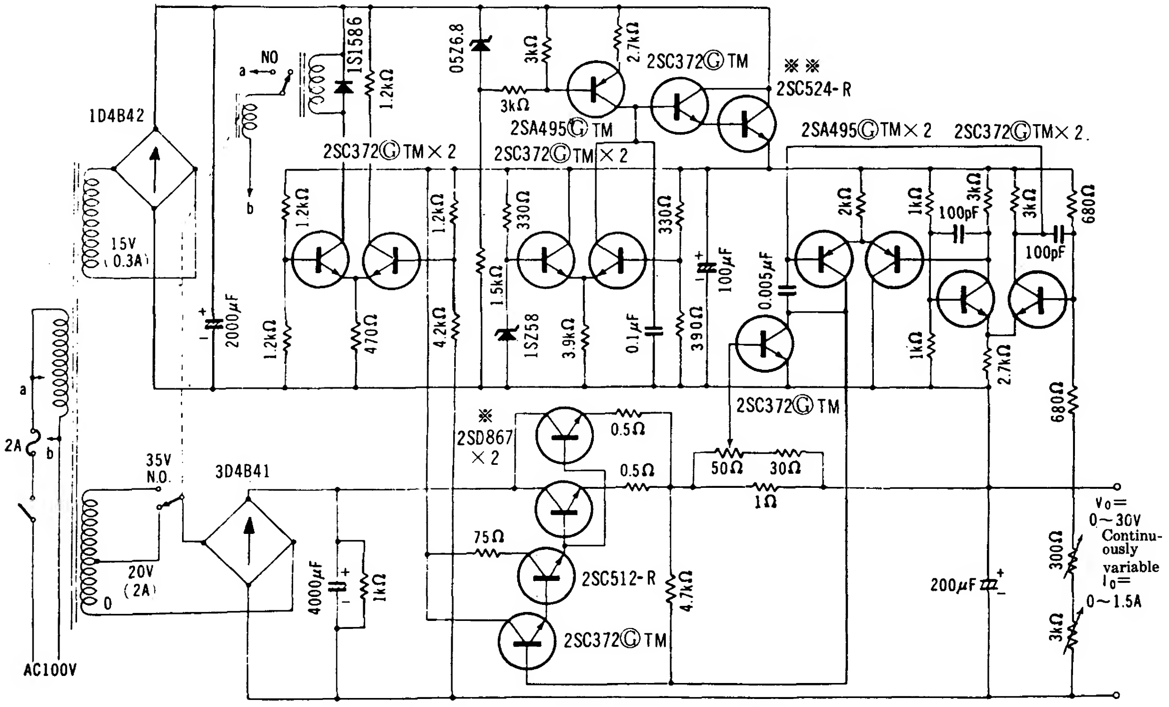
* Use a heat sink with thermal resistance of 2°C/W (for example, aluminum plate of 200 × 200 ×2 mm)

5. Constant-voltage regulator circuit
(4) 24V, 2A



* Use a heat sink with thermal resistance of 2°C/W (for example, aluminum plate of 200 × 200 × 2 mm)
Ambient temperature Ta = −20 ~ 70°C

6. Constant-voltage regulator circuit (5) 0 ~ 30V, 1.5A

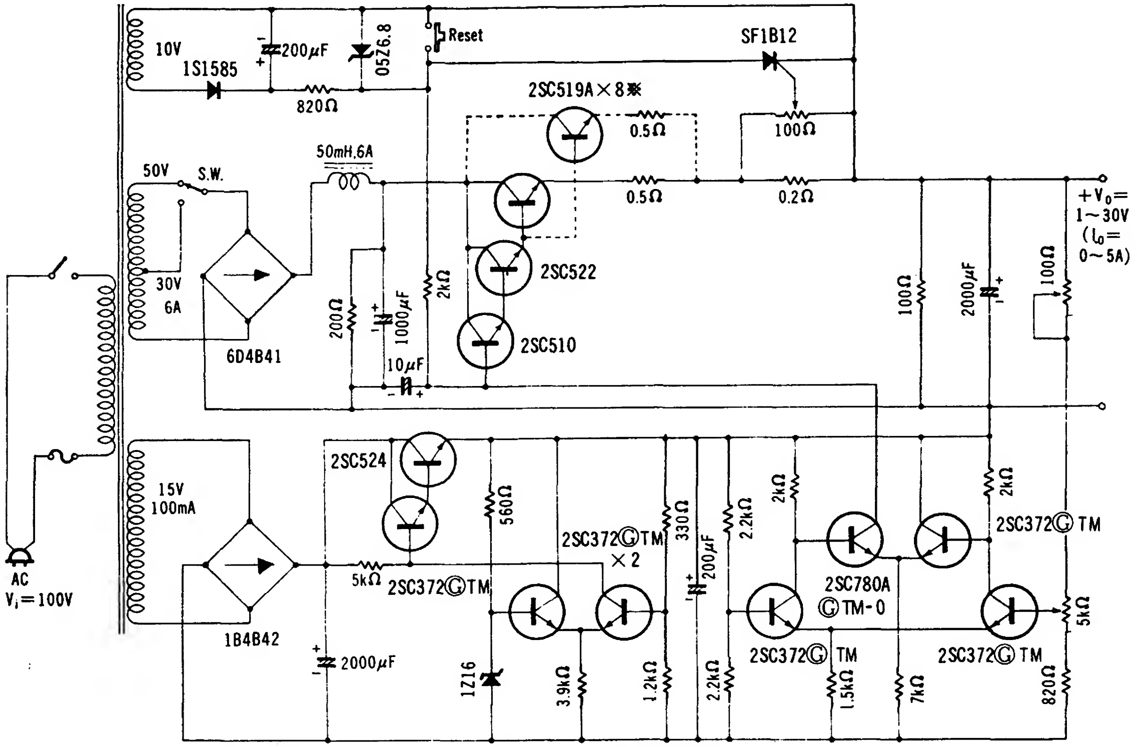


* Use a heat sink with thermal resistance of 2°C/W (for example, aluminum plate of 200 × 200 × 2 mm)

** Use a heat sink with thermal resistance of 6°C/W (for example, aluminum plate of 100 × 100 × 2 mm)
Internal resistance $r_0 > 5m\Omega$

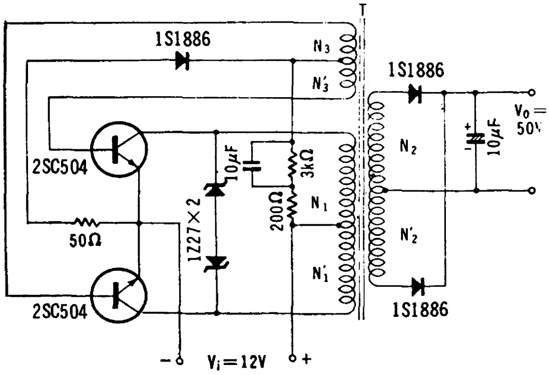
Ripple voltage : $V_{0r} < 1.5mV$ (p-p)
Output voltage fluctuation (±10%) caused by supply voltage fluctuation $\Delta V_0 < 2.5mV$
Ambient temperature Ta = −20 ~ 70°C

7. Constant-voltage regulator circuit



* 200 mm × 200 mm × 2 mm (Aluminum heat sink) (thermal resistance 2°C/W)
Note: For output voltage of 0 ~ 17V, use 30V tap for S.W. and for 17 ~ 30V use 50V tap.

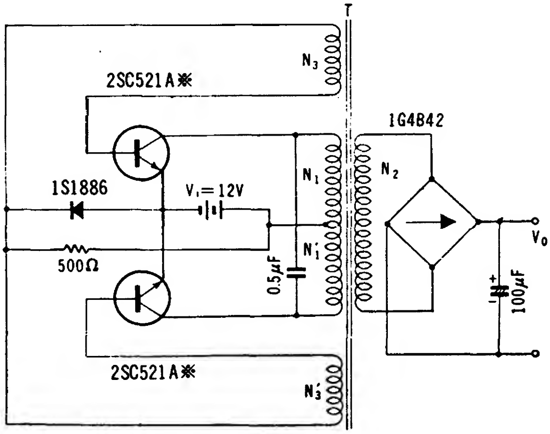
8. Multivibrator-type DC-DC converter circuit (1), 50V, 3W (V_i = 12V)



T : TDK ferrite core $H_{5A}P_{30/19}$

N_1, N_1' : 10T φ 0.32mm Oscillating frequency: f = 1kHz
N_2, N_2' : 43T φ 0.28mm Efficiency: η = 70%
N_3, N_3' : 2T φ 0.25mm Ambient temperature: Ta = −20 ~ 70°C

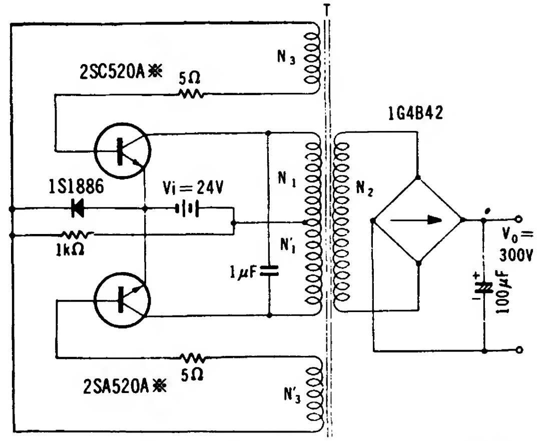
9. Multivibrator-type DC-DC converter circuit (2), 300V, 40W (V_i = 12V)



T : Toshiba RNE (Rectalloy) Core R-60
N_1, N_1' : 20T φ 1.0mm
N_2 : 550T φ φ 32mm
N_3, N_3' : 6T φ 0.32mm
※ : 100mm × 100mm × 2 mm
(Aluminum heat sink)

TDK ferrite core: $H_{5A}P_{30/19}$
Oscillating frequency: f = 10kHz
Efficiency: η = 80%
Ambient temperature: Ta = −20 ~ 70°C
T: Toshiba RNE (Rectalloy) Core R-60

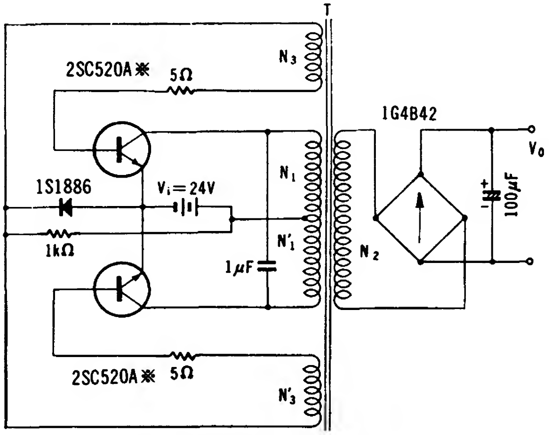
10. Multivibrator-type DC-DC converter circuit (3), 300V, 40W ($V_i = 24V$)



T : Toshiba RNE (Rectalloy) core R-45
N_1, N'_1 : 52T φ 0.8㎜
N_2 : 715T φ 0.32㎜
N_3, N'_3 : 5T φ 0.32㎜
※ : 100㎜ × 100㎜ × 2㎜ (Alminum heat sink)

Oscillating frequency: f = 1kHz
Efficiency: η = 80%
Ambient temperature: Ta = −20 ~ 70°C

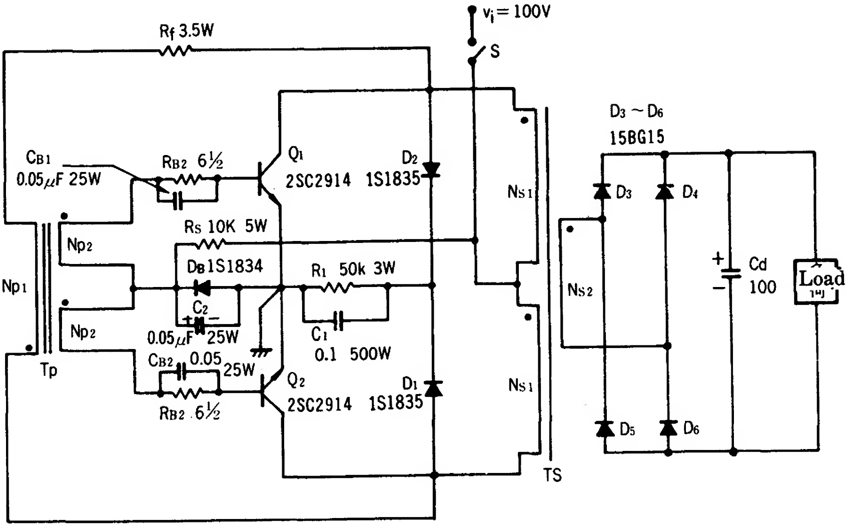
11. Multivibrator-type DC-DC converter circuit (4), 300V, 80W ($V_i = 24V$)



T : Toshiba RNE (Rectalloy) core R-60
N_1, N'_1 : 39T φ 1.0㎜
N_2 : 550T φ 0.5㎜
N_3, N'_3 : 5T φ 0.32㎜
※ : 100㎜ × 100㎜ × 2㎜ (Alminum heat sink)

Oscillating frequency: f = 1kHz
Efficiency: η = 80%
Ambient temperature: Ta = −20 ~ 70°C

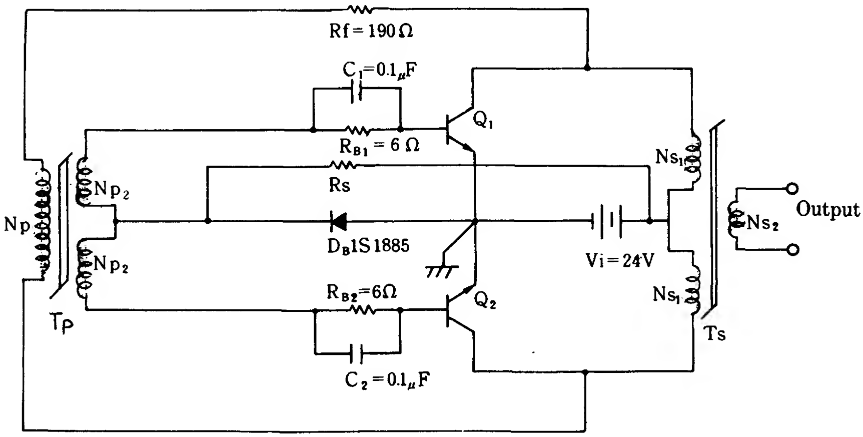
12. Multivibrator-type DC-DC converter circuit (5), 5V, 150W (V_i=100V)



2SC2914: (with heat sink, $\theta_f \leq 2.8$°C/W)
Tp; TDK H6AT10-20-5 Ferrite core
Ts; TDK EI60 H3C
Np_1; 75T ϕ 0.2mm
Np_2; 8T ϕ 0.5mm

Ns_1; 21T ϕ 1.2mm
Ns_2; 4T ϕ 2.5mm
Oscillating frequency; f=20kHz
Efficiency: η = 80%
Ambient temperature: Ta = −20~60°C

13. Multivibrator-type DC-AC inverter circuit (6) 100V, 80W, (V_i=24V)

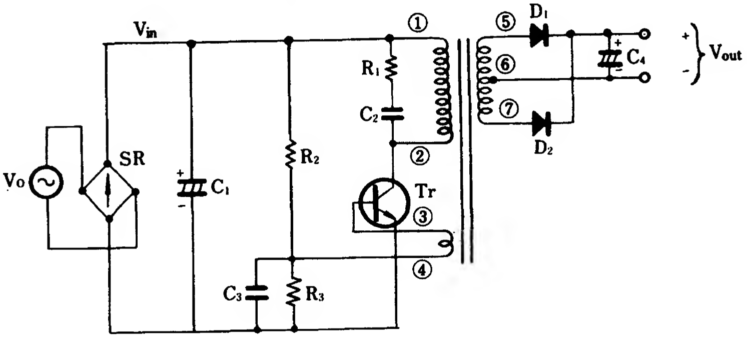


Q_1, Q_2: 2SC2913
or 2SC2555

Tp; TDK H7A EE12
Np_1; 29T ϕ 0.35mm
Np_2; 12T ϕ 0.52mm
Ns_1; 6T ϕ 1.8mm
Ns_2; 25T ϕ 0.17mm

Oscillating frequency; f=25kHz
Efficiency: η = 80%
Ambient temperature: Ta = −20°C~60°C

14. Example: Circuit incorporating a ringing choke-converter circuit



Specifications:

Supply voltage: Vo=AC100V
Output voltage: Vout=2.0V
Output current: Iout=1.0A
Oscillating frequency: f=22kHz

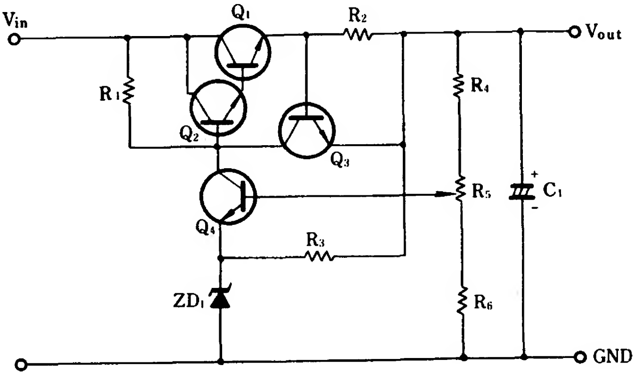
Oscillating cycle: T=45μsec
On-time: t_{on}=10μsec
Off-time: t_{off}=35μsec

Tr: 2SC2552
SR: 1D4B41
Δ_1: 1S1834
D_2: 1S1834
R_1: 220Ω 1W
T_1: EE-12.8, TDK H_3S
R_2: 68Ω ¼W
R_3 : 1.5kΩ ¼W

C_1: 4.7μF 250V
C_2: 0.001μ↑
C_3: 0.022μF
C_4: 220μF 35V

Note 1: C_4 is not required if used for battery charger circuit Application

15. 20V, 2A Output dropper regulator, (Dropper regulator circuit application)



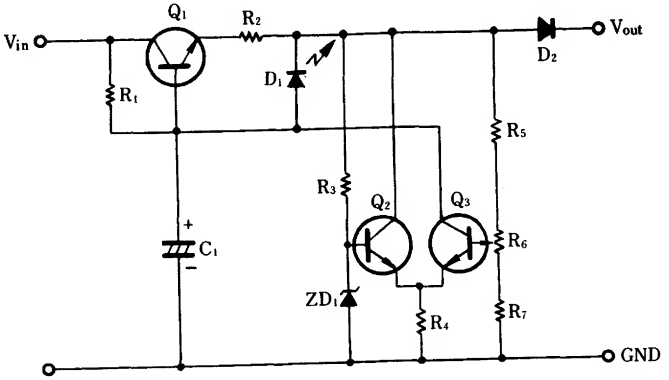
Specifications

Output voltage : 20V
Output current : 2A
Input voltage fluctuation : 25~30V
(Operating temperature) : (−20~60°C)

Q_1 : 2N3055
Q_2 : 2SD234Ⓖ
Q_3, Q_4 : 2SC372ⒼTM
ZD_1 : 05Z6.2
R_5 : 330Ω, VR
R_6 : 560Ω, ¼W
C_1 : 470μF, 25V

R_1 : 1.2kΩ, ¼W
R_2 : 0.3Ω, 2W
R_3 : 2.8kΩ, ¼W
R_4 : 1.2kΩ, ¼W

16. 12V, 1A Output dropper regulator



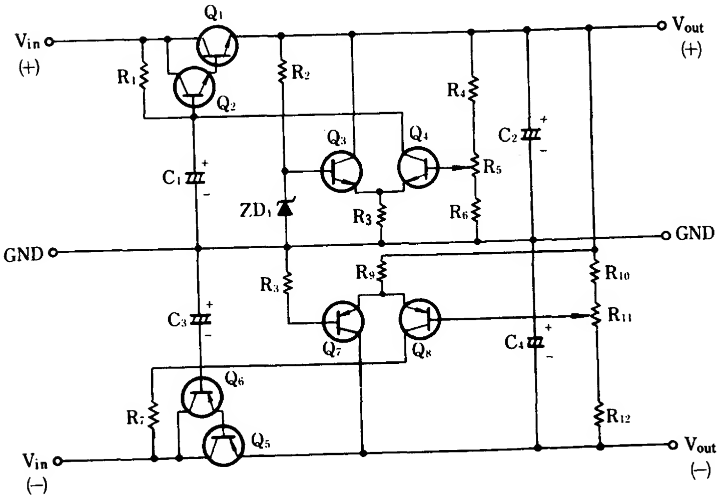
Specifications:
Output voltage: 12V
Output current: 1A
Input voltage fluctuation: 15~18V

Q_1 : 2SD234Ⓖ(or 2SD880)
Q_2, Q_3 : 2SC372ⒼTM
ZD_1 : 05Z5.1
D_1 : TLR103
D_2 : 1S1885
C_1 : 10μF, 25V

R_1 : 470Ω, ¼W
R_2 : 20Ω, 2W
R_3 : 1.5kΩ, ¼W
R_4 : 330Ω, ¼W
R_5 : 680Ω, ¼W
R_6 : 100Ω, VR
R_7 : 470Ω, ¼W

17. ±15V, 2A Output dropper regulator

Shown below is applied circuit incorporating transistors 2N3771 and 2N4398.



Specifications
Output voltage : ±15V
Output current : 2A
Input voltage fluctuation
: 18~24V

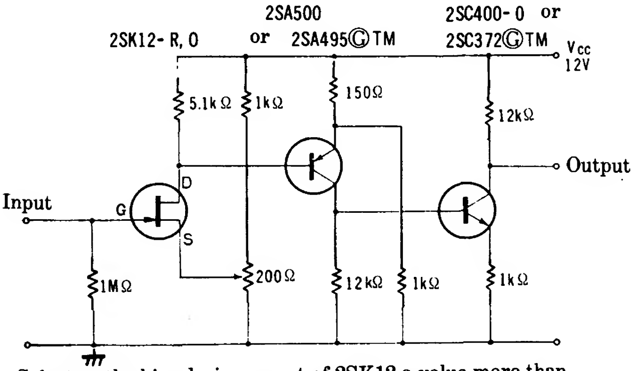
Q_1 : 2N3771
Q_2 : 2SC2562
Q_3 : 2SC2240
Q_4 : 2SC2240
Q_5 : 2N4398
Q_6 : 2SA1012
Q_7, Q_8: 2SA970

ZD_1 : 05Z5.6
R_1 : 330Ω, ¼W
R_2 : 2kΩ, ¼W
R_3 : 220Ω, ¼W
R_4 : 680Ω, ¼W
R_5 : 500Ω, VR
R_6 : 560Ω, ¼W

R_7 : 330Ω, ¼W
R_8 : 1kΩ, ¼W
R_9 : 560Ω, ½W
R_{10}, R_{12} : 1kΩ, ¼W
R_{11} : 1kΩ, VR
C_1, C_3 : 10μF, 25V
C_2, C_4 : 470μF, 25V

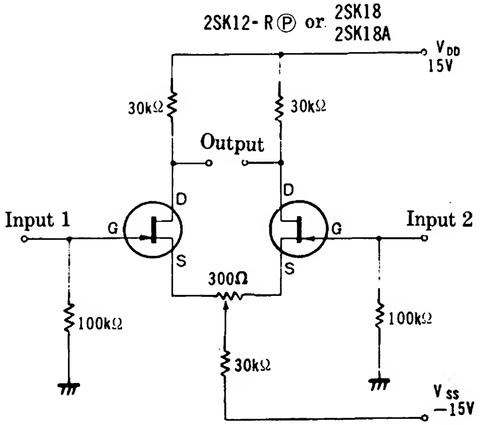
Circuits incorporating FET's

1. Amplifier circuit with direct-coupled FET, voltage gain 62 dB, min. sensing signal ~ 1mV

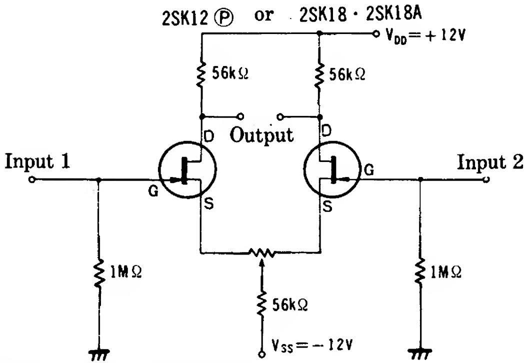


Select as the bias drain current of 2SK12 a value more than that at which the temperature coefficient of drain current may be zero, the drain current thus possessing a negative temperature coefficient. Then compensate the temperature to offset this temperature coefficient with that of VBE of the subsequent stage to reduce the temperature drift of output.

2. FET differential amplifier circuit (1), voltage gain 26 dB



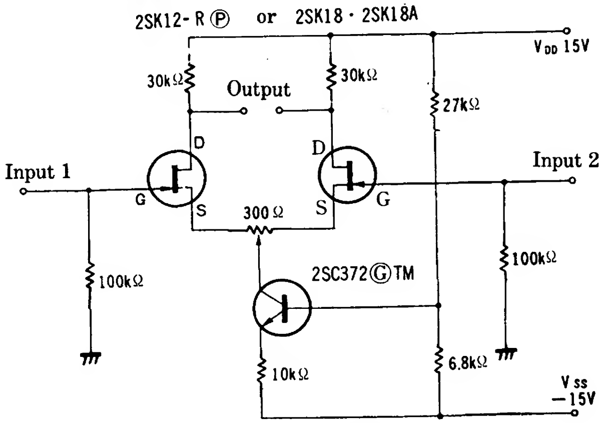
3. FET differential amplifier circuit (2), voltage gain 16 dB



Equivalent input temperature drift voltage
($V_D/\Delta T$):40μV/°C
Voltage drift
(V_D/V_{DD}):0.04%

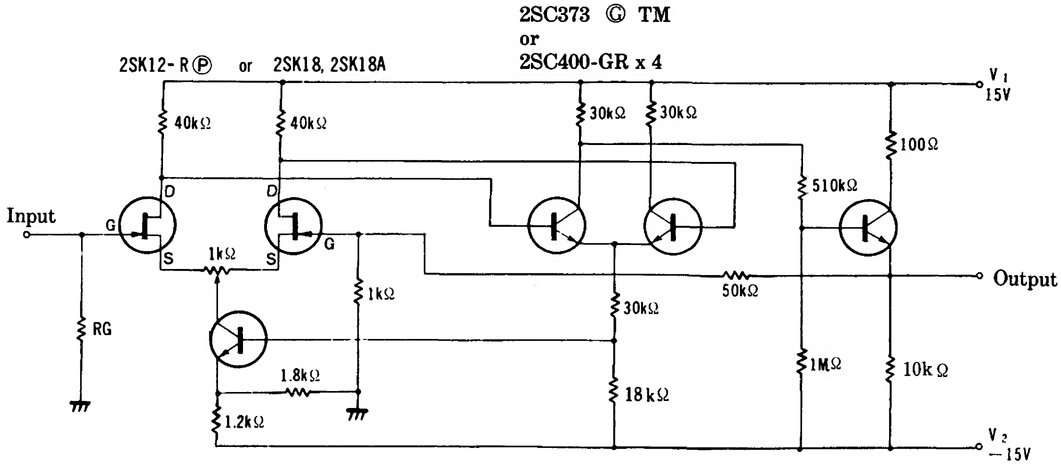
Voltage drift
(V_D/V_{SS}) 0.9%
V_D : Equivalent input temperature drift voltage (V)

4. FET differential amplifier circuit (3), voltage gain 26 dB

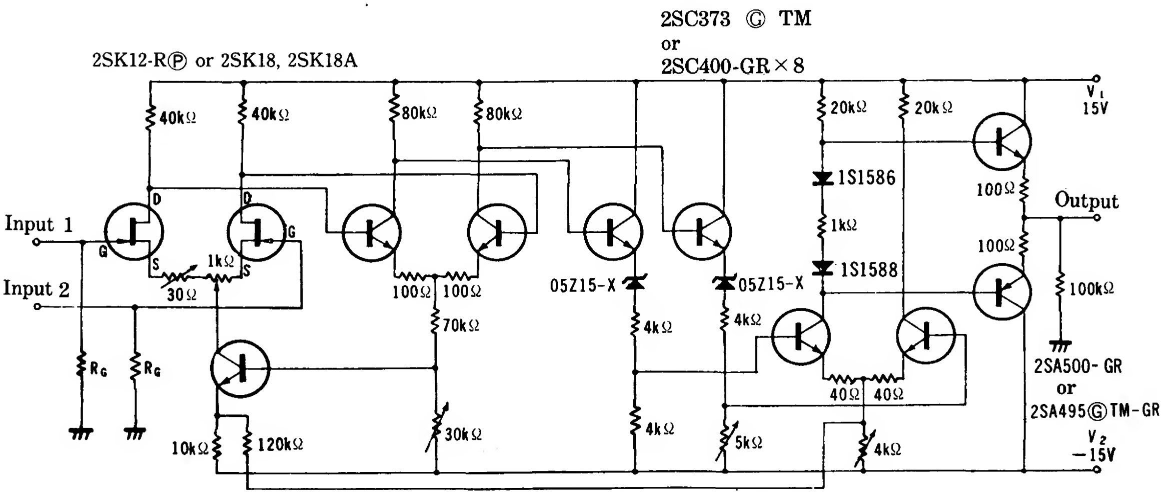


Common mode rejection ratio CMR–76dB ($\Delta I_{DSS}/I_{DSS}=10\%$)

5.- FET 2-stage differential-amplifier circuit, voltage gain 34 dB (open loop gain: 53 dB)



6. FET 3-stage differential amplifier circuit (open loop gain 98 dB)

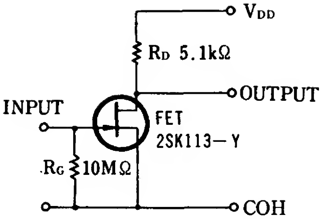


7. Digital switch

Specifications

Supply voltage	: $V_{DD}=20V$
Input drive voltage	: $V_{GS(ON)}=0V$
	$V_{GS(OFF)}=-15V$
Input impedance	: 10MΩ

Example

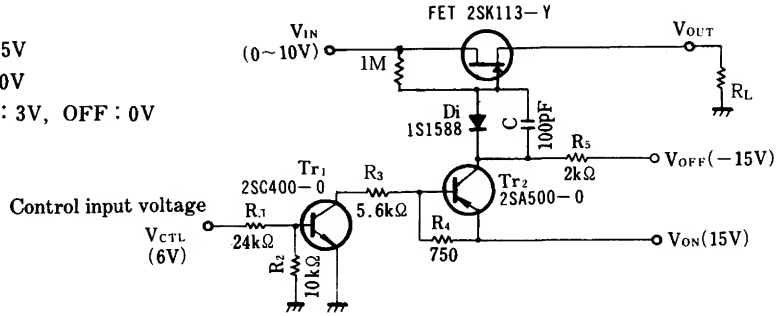


FET used	2SK113−Y
Operating temperature	Ta=−20°C ~ +100°C

8. Analog switch

Specifications

Supply voltage	: $V_{ON}=15V$
	$V_{OFF}=-15V$
Input voltage	: $V_{IN}=0\sim10V$
Control voltage	: V_{CTL}=ON : 3V, OFF : 0V



9. Sample hold circuit

Circuit diagram

Example of Circuit

Specifications

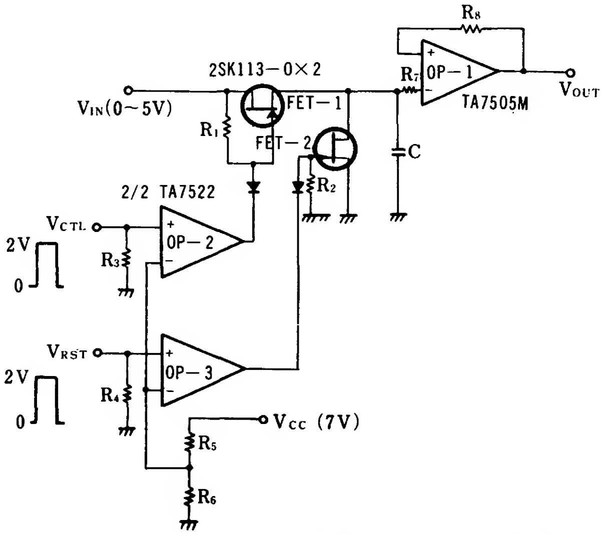
Supply voltage	: $V_{CC}=7V$, $V_{EE}=-9V$
Input voltage	: $V_{IN}=0\sim5V$
Control voltage	: $V_{CTL}=2V$
Reset voltage	: $V_{RST}=2V$
Sampling time	: 10ms
Retention time	: 10s
Operating temperature	: −20°C ~ 50°C

※ $R_7=R_8=2\sim3k\Omega$

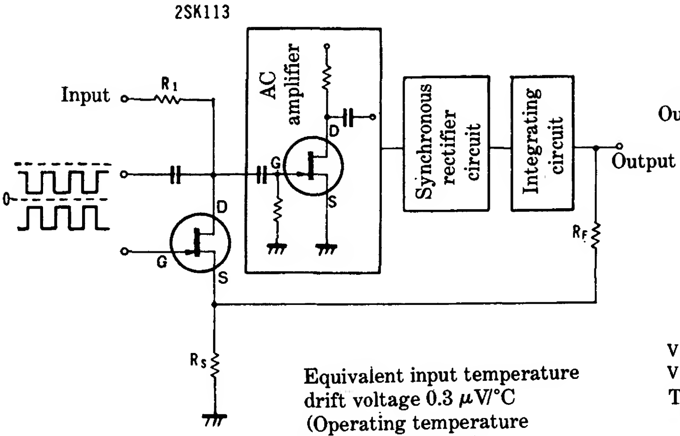
R_7 : OP Amp For input protection

R_8 : For offsetting output and reducing drift

Transistors used	: FET : 2SK113−Y
	Tr_1 : 2SC400−O
	Tr_2 : 2SA500−O

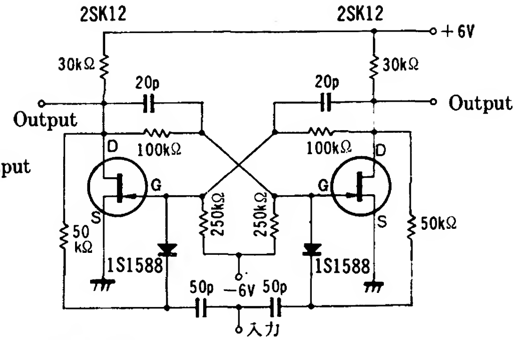


10. FET chopper amplifier circuit



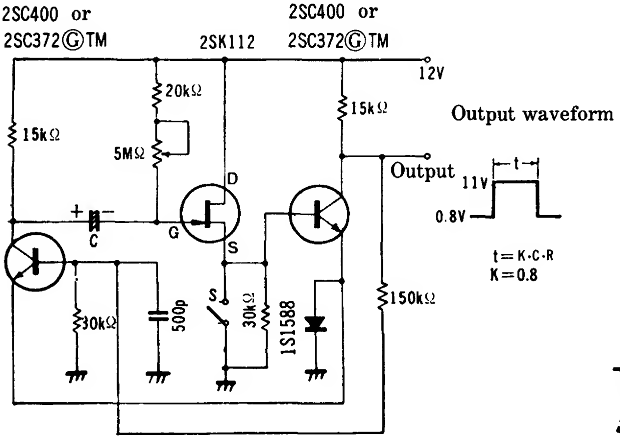
Equivalent input temperature drift voltage 0.3 μV/°C (Operating temperature range 0°C ~ 60°C)

11. FET flip-flop circuit

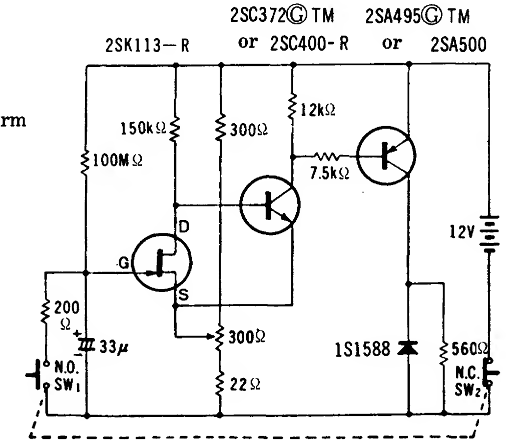


V_T (max) = 20V
V_T (min) = 4.5V V_T: Trigger voltage
Trigger frequency f = 0.5 ~ 100kHz)

12. FET timer circuit (1)

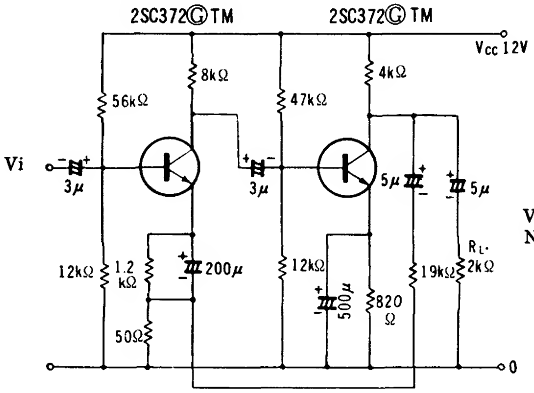


13. FET timer circuit (2) (operating time: 10 min.)



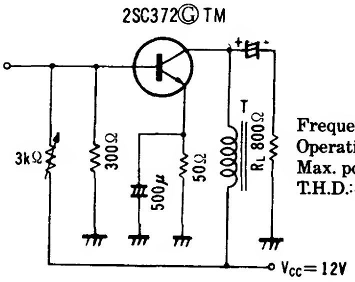
Low-frequency amplifier circuit

1. RC coupled amplifier circuit



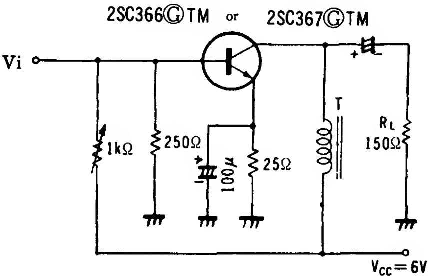
Voltage gain : 48dB (f = 8Hz ~ 2MHz Rg = 1kΩ)
Negative feedback : 15dB

2. Class A single amplifier circuit (1), Po = 55mW



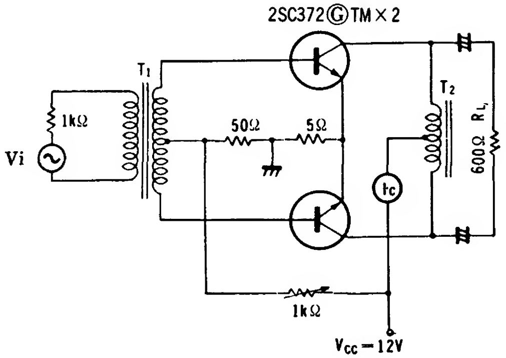
Frequency: f = 1kHz
Operating current: 15mA
Max. power gain: 44dB
T.H.D.: 4.9% (at maximum output)

3. Class A single amplifier circuit (2), Po = 75mW



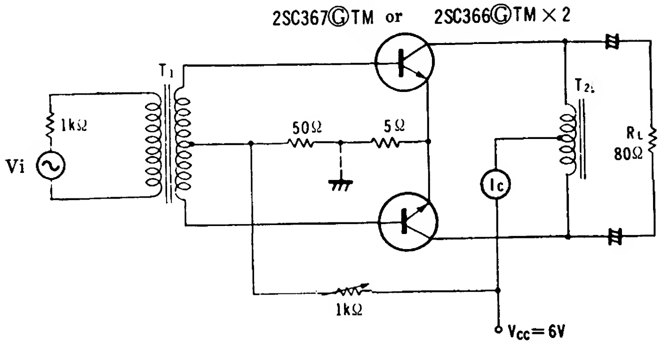
Frequency: f = 1kH
Operating current: 22mA
Max. power gain: 31dB
T.H.D. 5.1% : (at maximum output power)

4. Class B push-pull amplifier circuit (1), Po = 200mW



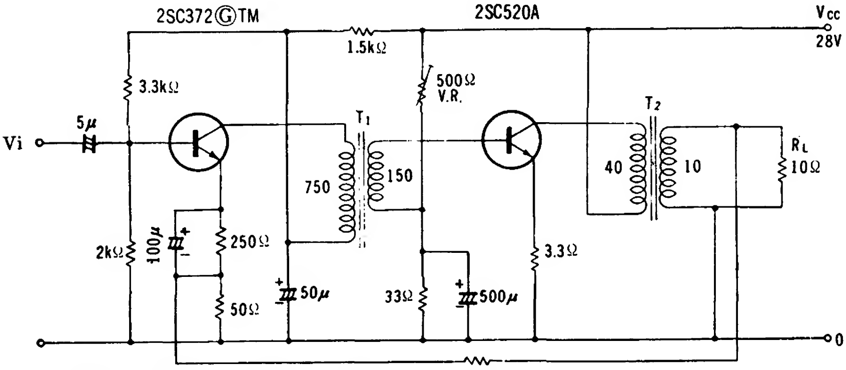
Frequency : f = 1kHz
Operating current:20mA
(average value of the two)
Max. power gain:30.1dB
T.H.D. 2.8% (at maximum output power)

5. Class B push-pull amplifier circuit (2), Po = 400mW



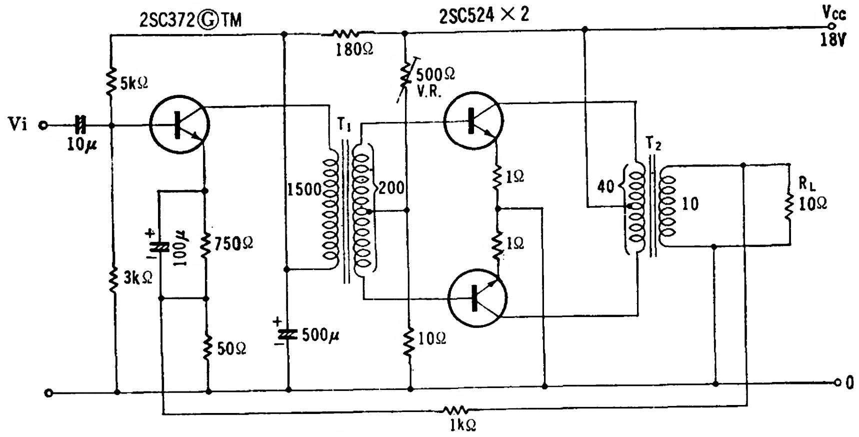
Frequency : f = 1kHz
Operating current:140mA
(average value of the two)
Max. power gain 21dB
T.H.D.:4.7% at maximum output power

6. Transformer-coupled Class A power amplifier circuit, Po = 5W (Vi = 0.4V)



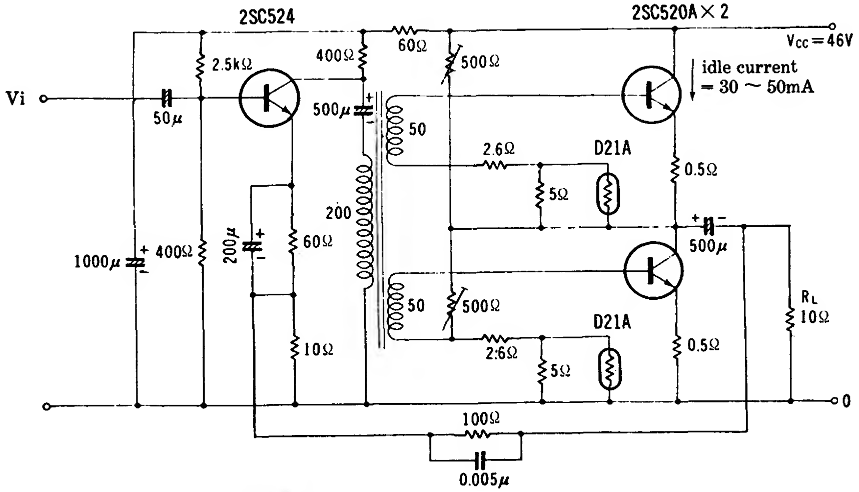
Ambient temperature Ta = −20 ~ 60°C

7. Transformer-coupled Class B power amplifier circuit, Po = 7W (Vi = 0.6V)



Ambient temperature:Ta = −20 ~ 60°C

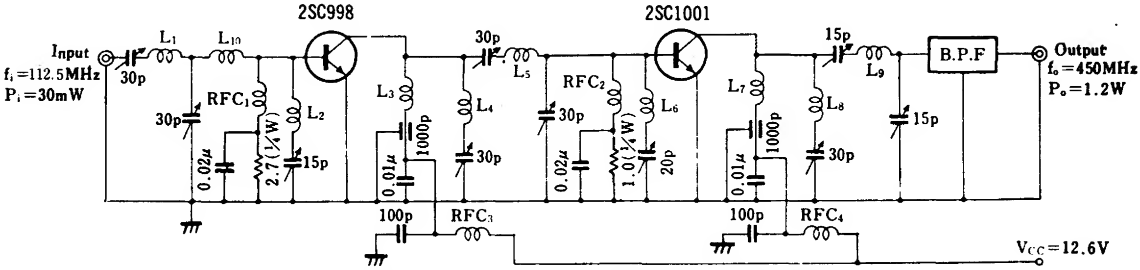
8. SEPP power amplifier circuit with input transformer, Po = 200W (Vi = 1.5V)



Ambient temperature:Ta = −20 ~ 60°C

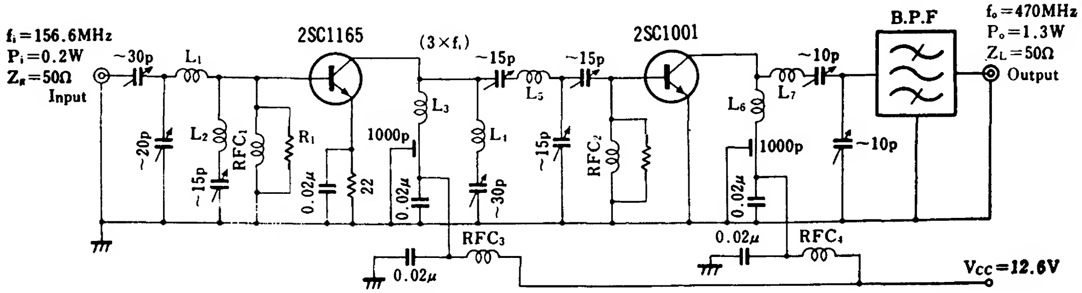
High-frequency power amplifier circuit

1. Double-multiplier power amplifier circuit (112.5 MHz～450 MHz)



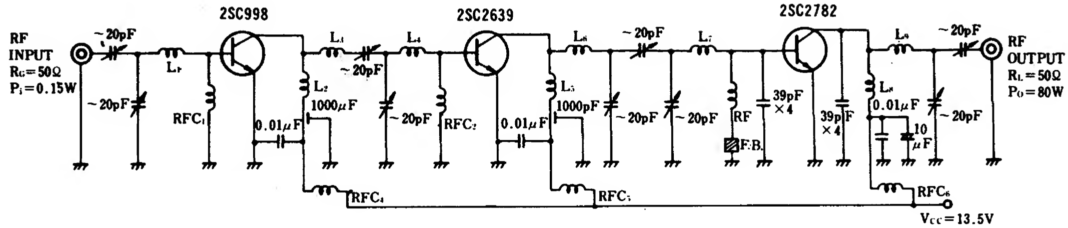
L_1: ϕ 0.8mm Silver-plated copper wire, 2T, 7ID, 3P
L_2: ϕ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
L_3: ϕ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
L_4: ϕ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
L_5: ϕ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
L_6: ϕ 0.8mm Silver-plated copper wire, 1T, 7ID
L_7: ϕ 0.8mm Silver-plated copper wire, 1T, 7ID
L_8: ϕ 0.8mm Silver-plated copper wire, 3T, 7ID, 2P
L_9: ϕ 0.8mm Enamel-coated copper wire, 2T, 7ID, 2P
L_{10}: ϕ 0.8mm Enamel-coated copper wire, 2T, 7ID, 2P
RFC_1: ϕ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
RFC_2: ϕ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
RFC_3: ϕ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
RFC_4: ϕ 1.0mm Enamel-coated copper wire, 10T, 5ID,
B.P.F: BAND PASS FILTER

2. Triple-multiplier 2-stage power amplifier circuit (156.6 MHz～470 MHz)



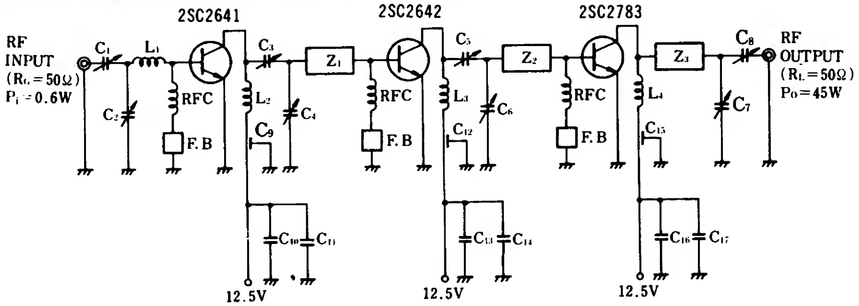
L_1: ϕ 0.8mm Silver-plated copper wire, 2T, 10ID, 2P
L_2: ϕ 1.2mm Silver-plated copper wire, 1T, 10ID
L_3,L_4: ϕ 0.8mm Silver-plated copper wire, 1T, 8ID
L_5: ϕ 1.2mm Silver-plated copper wire, 2T, 10ID, 2P
L_6: ϕ 1.2mm Silver-plated copper wire, 1T, 8ID
L_7: ϕ 1.2mm Silver-plated copper wire, 2T, 8ID, 2P
RFC_1,RFC_2: ϕ 0.6mm Enamel-coated copper wire, 15T, 3.5ID
RFC_3: ϕ 1.0mm Enamel-coated copper wire, 20T, 8ID
RFC_4: ϕ 1.0m Enamel-coated copper wire, 17T, 8ID
B.P.F: BAND PASS FILTER

3. Power amplifier circuit (175 MHz, FM 70W)



L_1: φ1mm Silver-plated copper wire 1T, 8ID
L_2: φ1mm Silver-plated copper wire 2T, 8ID
L_3: φ1mm Silver-plated copper wire 2T, 8ID
L_4: φ1mm Silver-plated copper wire 2T, 8ID
L_5: φ1mm Silver-plated copper wire 2T, 8ID
L_6: φ1mm Silver-plated copper wire 1T, 8ID
L_7: φ1mm Silver-plated copper wire 1T, 10ID
L: φ1.5mm Silver-plated copper wire 2T, 10ID
L_9: φ1.5mm Silver-plated copper wire 1T, 10ID
RFC_1, RFC_2: φ0.5mm enamel wire closely wound around 220Ω solid resistance
RFC_3: φ1mm enamel-coated wire 10T, 6ID
RFC_4, RFC_5: φ1mm enamel-coated wire 10T, 6ID
RFC_6: φ1.5mm enamel-coated wire 10T, 6ID

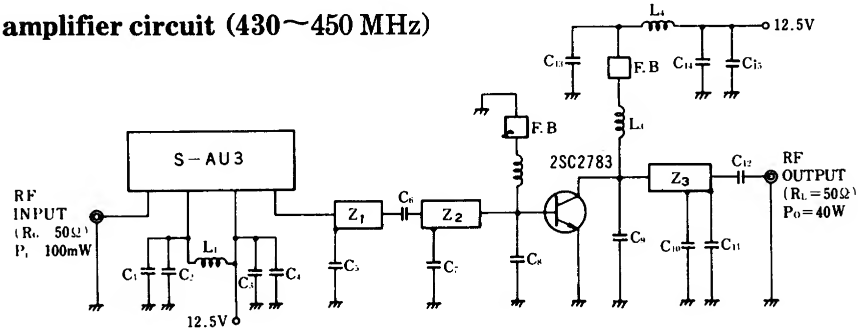
4. Power amplifier circuit (470 MHz, FM 40W)



C_1, C_2, C_3, C_4, C_5, C_6: ~8pF Ceramic trimmer capacitor
C_7, C_8: ~20pF Air trimmer capacitor
C_9, C_{12}, C_{15}: 1000pF Feedthrough capacitor
C_{10}, C_{13}, C_{16}: 0.05μF Ceramic capacitor
C_{11}, C_{14}, C_{17}: 10μF Electrolytic capacitor

F.B.: Ferrite bead
L_1: 0.3 mm-thick copper plate, 4mm wide φ8ID, 1/2T
L_2, L_3, L_4: φ1mm silver-plated copper wire φ3ID, 2T
RFC: φ0.8mm Enamel-coated copper wire φ3ID, 10T
Z_1,Z_2,Z_3: 4x10mm Board pattern
Board: paper epoxy board

5. Power amplifier circuit (430~450 MHz)



C_1, C_4, C_{15}: 10μF
C_2, C_3, C_{13}, C_{14}: 0.05μF
C_5, C_7, C_{10}, C_{11}: 5pF Ceramic chip capacitor
C_6: 240pF Ceramic chip capacitor
C_8, C_9: 50pF (10pFx5) Ceramic chip capacitor
C_{12}: 660pF Ceramic chip capacitor

L1, L2, L4: φ0.5mm copper wire φ2ID, 5T
L_3: φ0.5mm copper wire φ2ID, 3T
F.B: Ferrite bead
Z_1: 5x11mm Microstrip line
Z_2: 5x29mm Microstrip line
Z_3: 5x32mm Microstrip line
Board: ϵ_r=2.7 t=1.6mm Teflon-glass board

Applied circuit of large-power transistors and transistor modules (motor drive circuit)

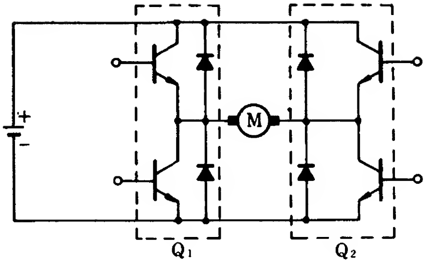


Fig. 1

1. DC motor control (1)

To be employed when using a DC motor control for quick starting/stopping, reverse rotating, and controlling speeds of motors:

Application: Computer-controlled NC machines, machine tools, and spinning and weaving machines

Recommended transistors (Darlington transistors):

Q_1 and Q_2: MG30G2CL 3, MG50G2CL 3,

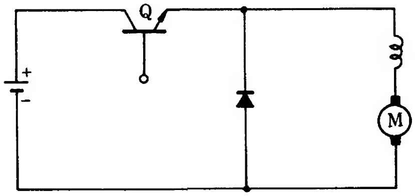


Fig. 2

2. DC motor control (2)

To be employed when controlling DC motor speeds with relative ease

Application: Electric cars, battery-operated vehicles (such as golf carts and fork lifts)

Recommended transistors (Darlington transistors):

Q = 2SD648, 2SD698

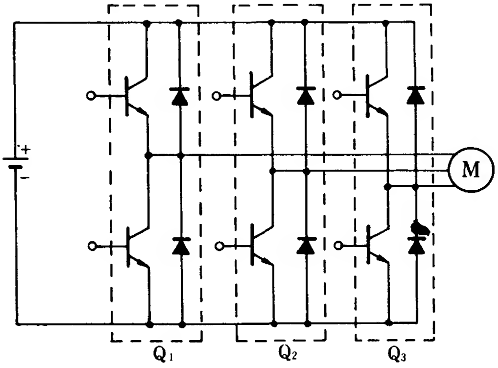


Fig. 3

3. AC motor control

Induction motors which require less maintenance are employed when motor speeds are continuously controlled, thereby not so much time need be allocated to maintenance.

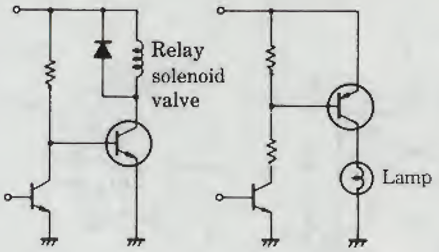
Application: 3-phase induction motor control for brush-less electronic motors, machine tools, marine motors, spinning and weaving machines

Recommended transistors (Darlingron transistors):

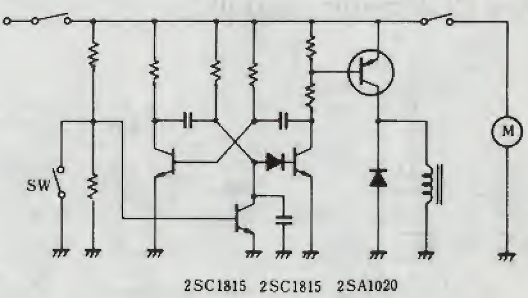
Q_1 and Q_2 = MG3OG2CL2, MG5OG2CL2 MG75H2CL1, MG100H2CL1

Application of low-saturation voltage transistors

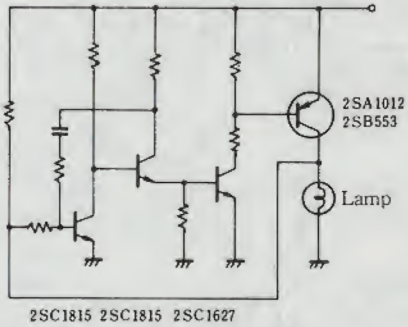
1. Various inductance and lamp drives



2. Wiper control



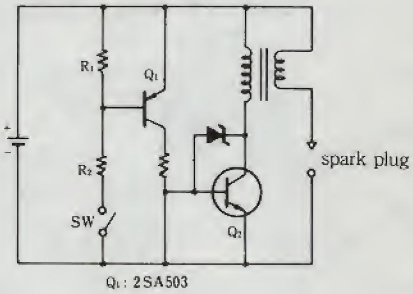
3. Flasher



4. Ignitor

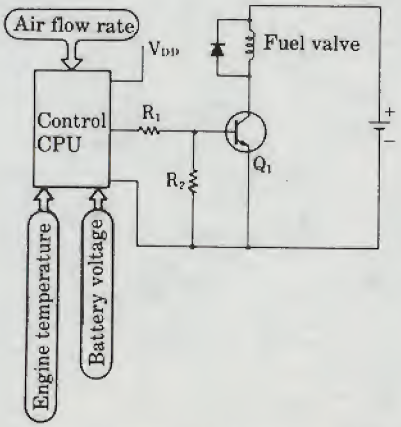
Recommended Darlington transistors (Q_2)
Method (1): 2SD685, 2SD799
Method (2): 2SD798, 2SD1088

(1) Battery drive

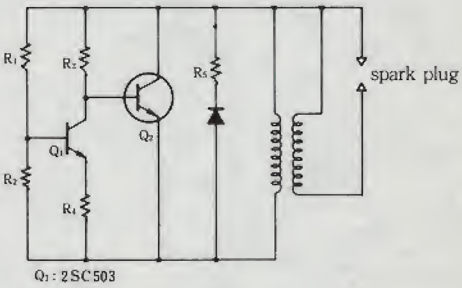


5. Electronic fuel injection control

Recommended Darlington transistors (Q_1): 2SD1087
2SD1500'
2SD633'

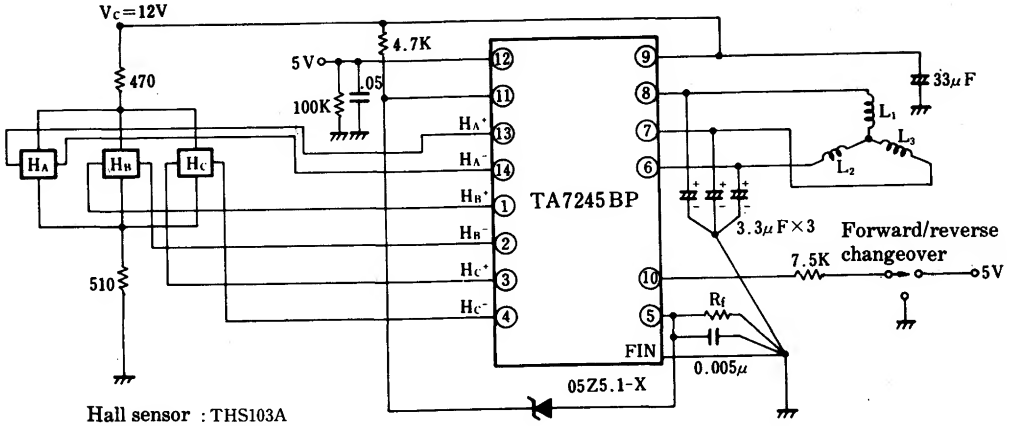


(2) Magnet drive



GaAs Hall sensor

1. Example circuit using GaAs Hall sensor (Hall motor control)



Hall sensor : THS103A

L1, L2, L3 : Field coil

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MEMO

MEMO

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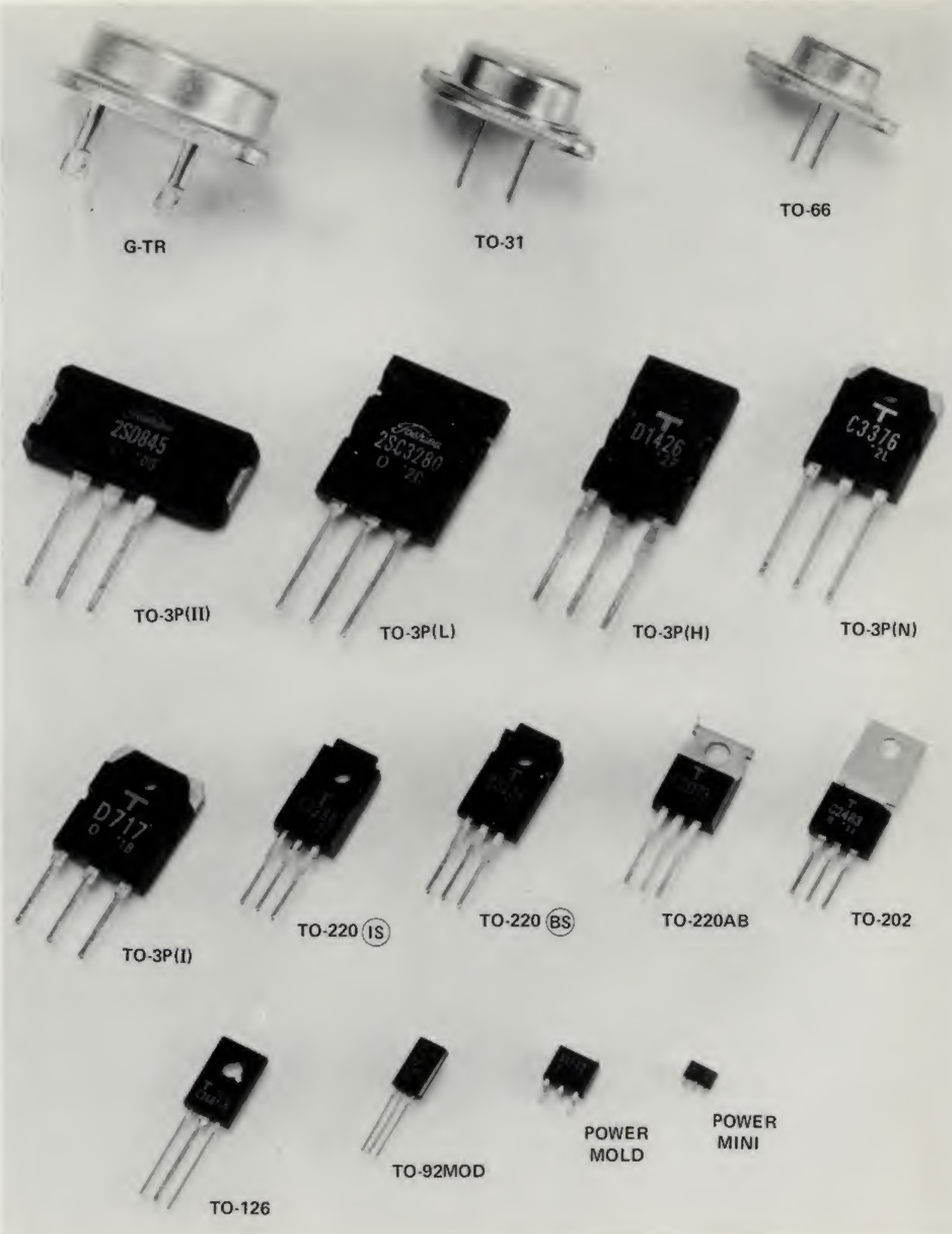
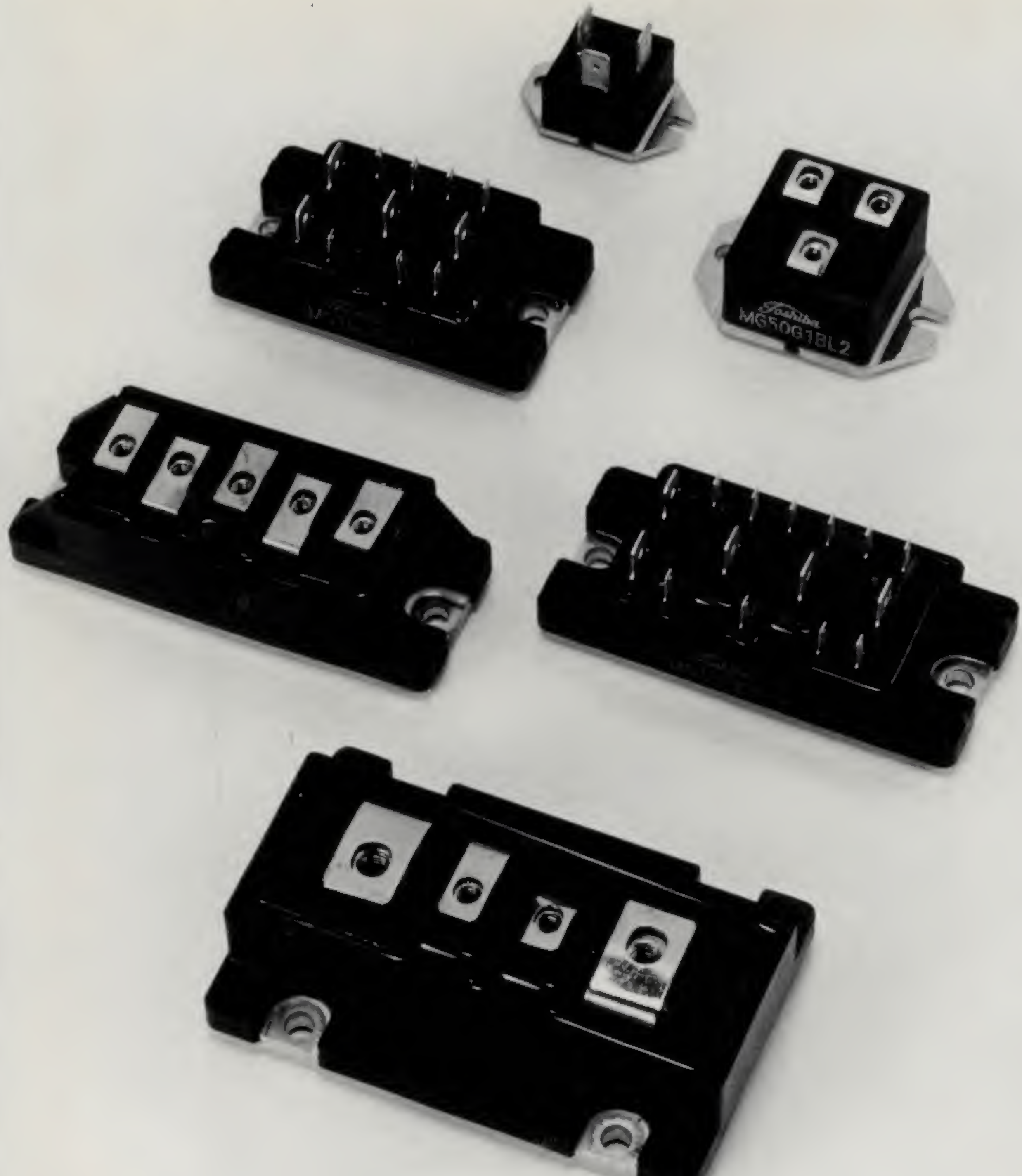

G-TR
TO-31
TO-66
TO-3P(II)
TO-3P(L)
TO-3P(H)
TO-3P(N)
TO-3P(I)
TO-220 (IS)
TO-220 (BS)
TO-220AB
TO-202
TO-126
TO-92MOD
POWER MOLD
POWER MINI



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